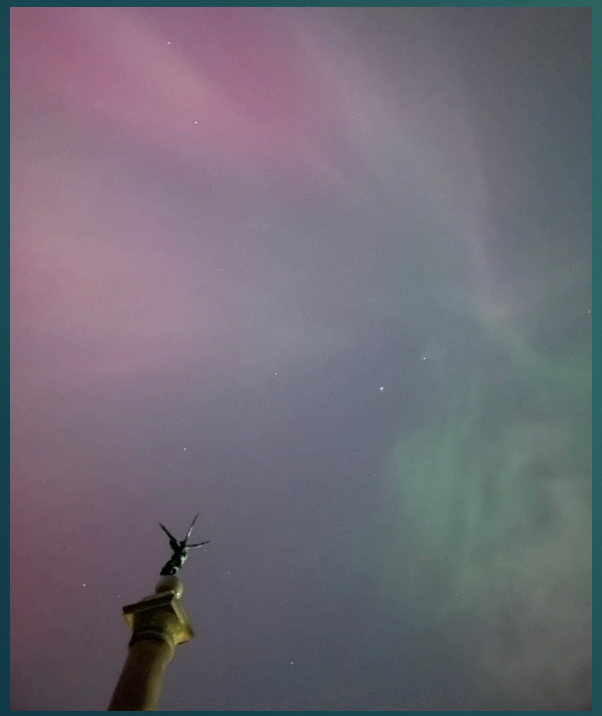
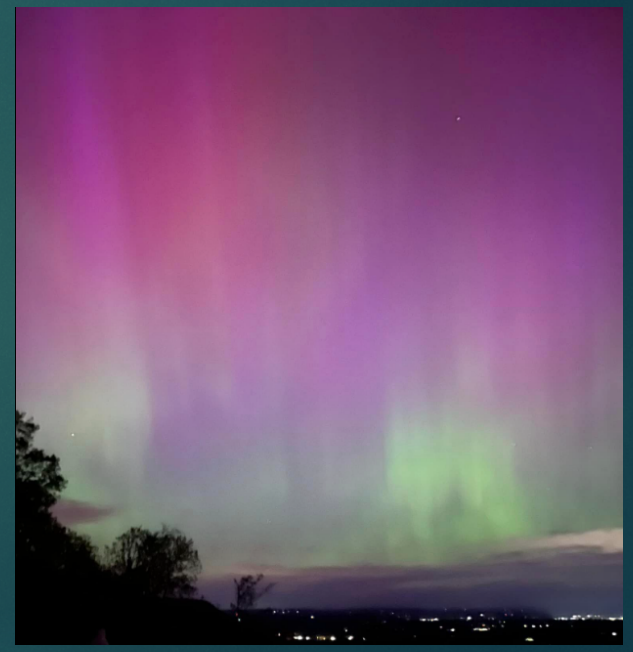
On the Effects of the 10 May 2024 G5 Geomagnetic Storm Observed in the Hudson Valley

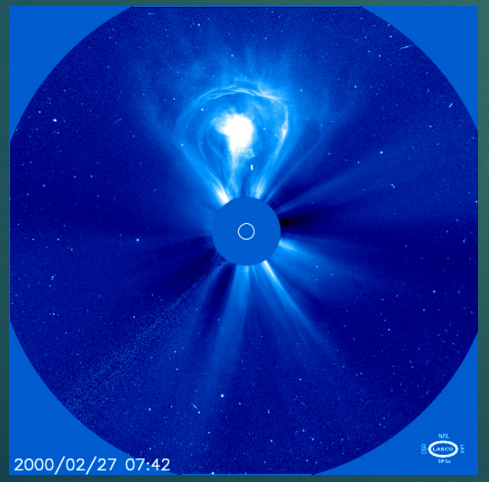


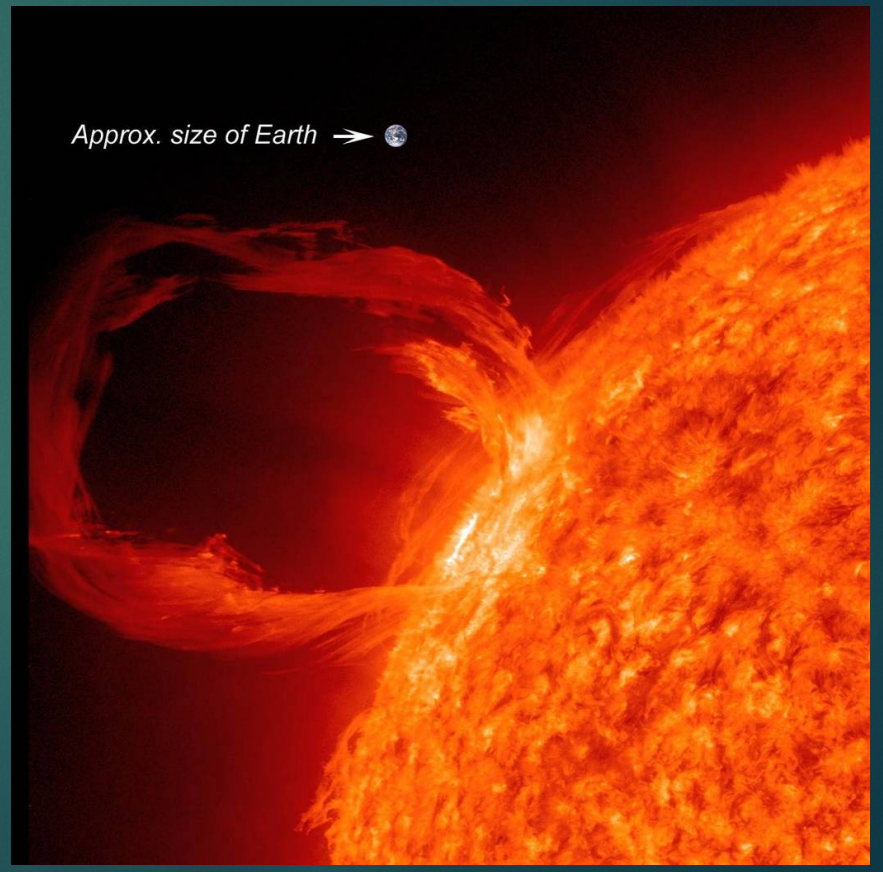
JASON DERR, JOANNA HALFHILL,
DIANA LOUCKS, STEPHEN HAMILTON



Solar Wind Driving

- Sunspots
- Prominences
- Flares – X-class very intense
- Coronal Mass Ejections





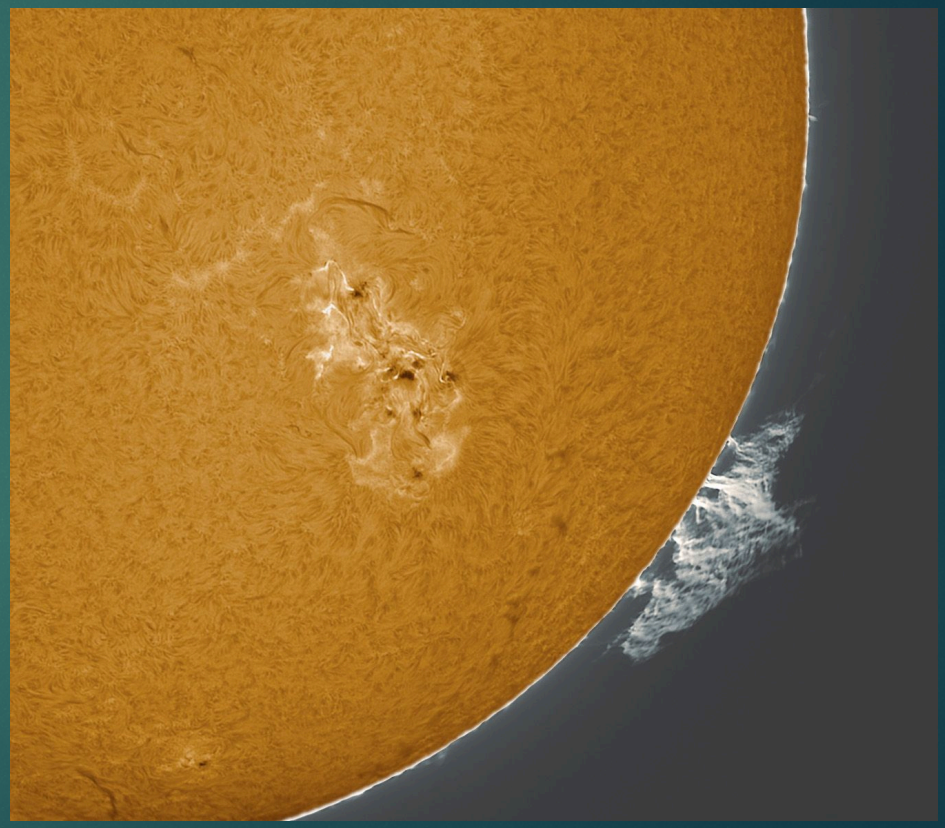
Solar Activity Timeline

May 7-May 8
- 3664 and 3668 merge, 3664 dominates
- Radio bursts in GHz range

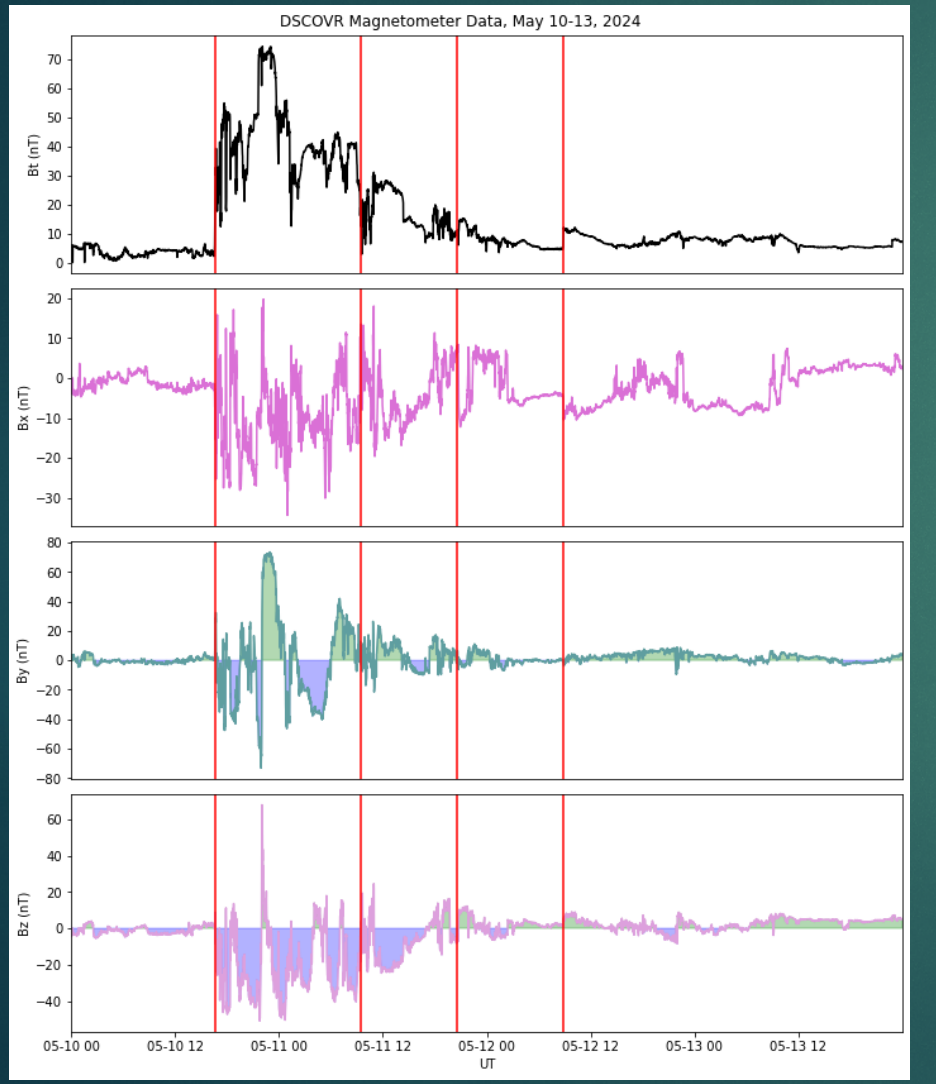
May 8
- 05:30 – CME SW of Earth (1)
- 08:00 – Halo CME (2)
  - Big X-class flare w/ 2nd one
- 13:30 – Halo CME (3)
- 21:00 – NWW of Earth filament erupts (travels east of Earth) (4)
- 4th flare

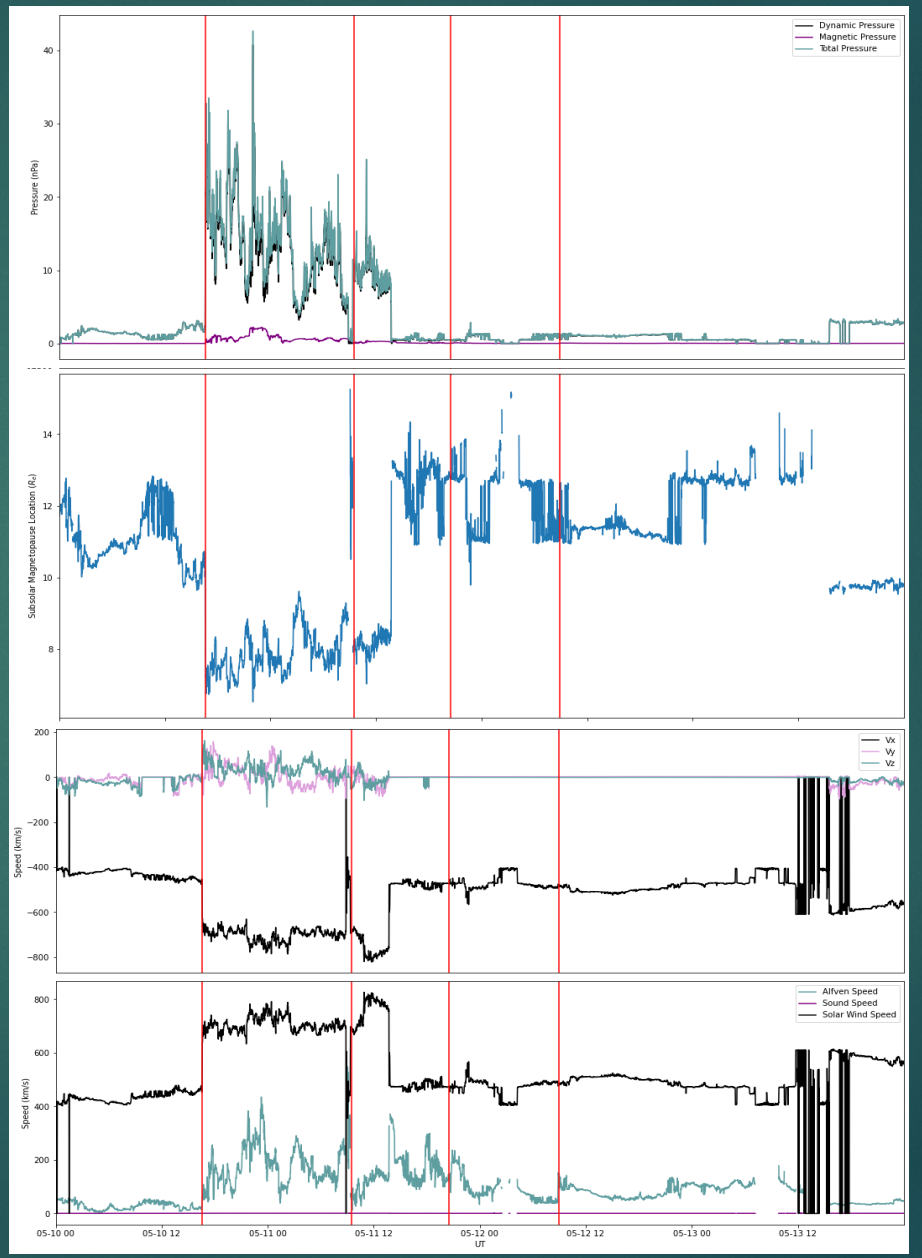
May 9
- 00:30 – Halo CME (5)
- 10:00 – Halo CME (6)
  - X-class flare
- 21:00 – Halo CME (7)
  - X-class flare

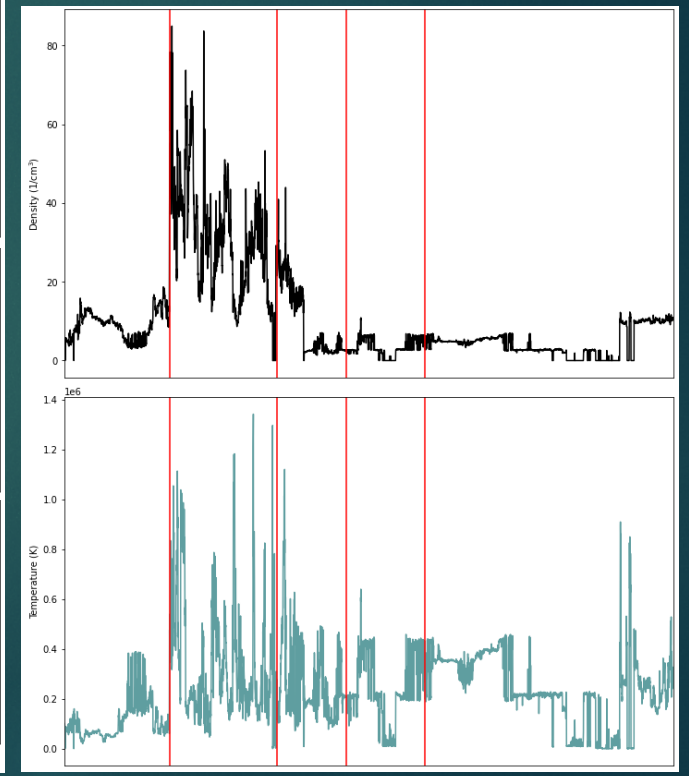
- Region 3664 rotates away from Earth-directed



L1 DISCOVR Data

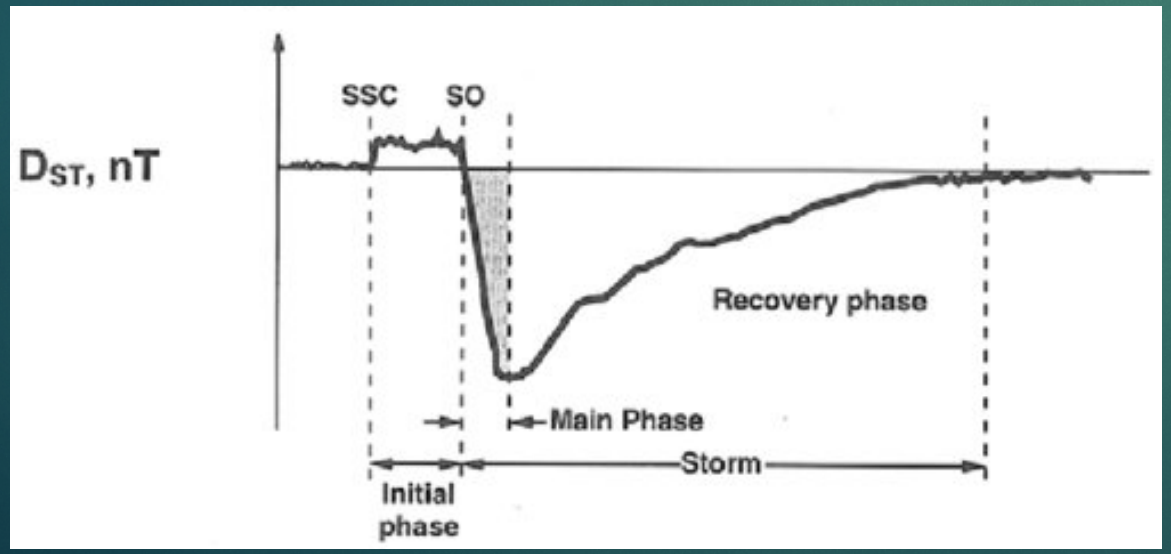


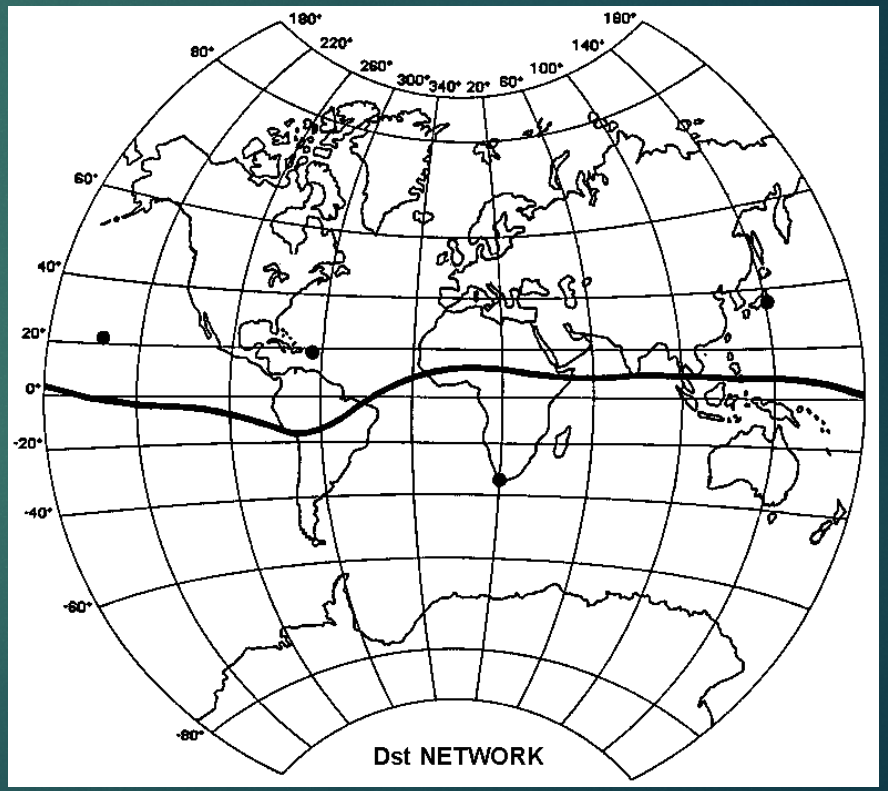




Geomagnetic Storms

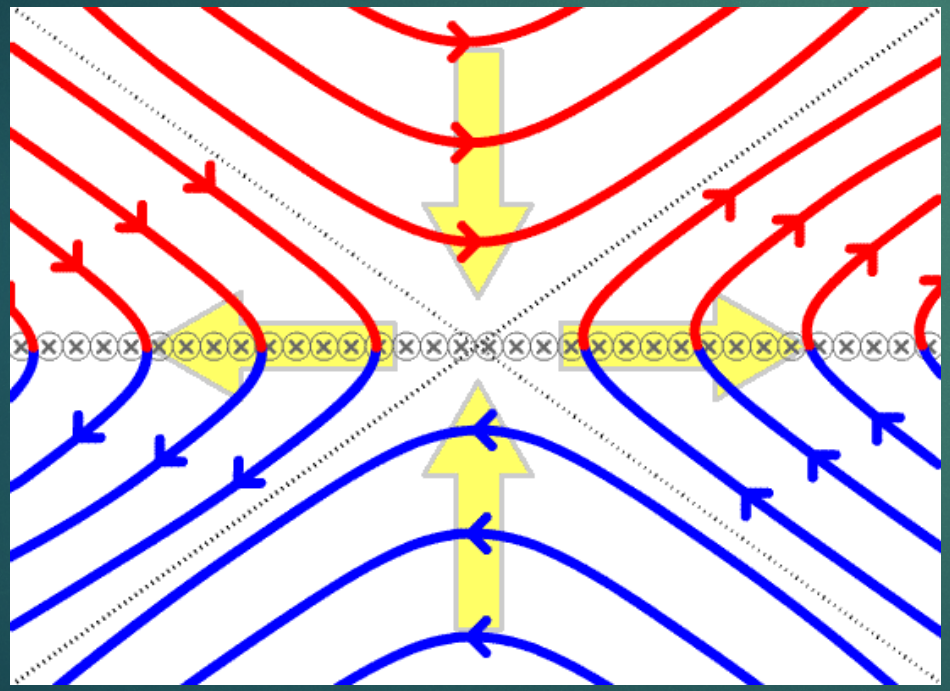
- Dst, Ring Current
- Min Dst ~ -412 nT
- 2003 Halloween Storm min Dst ~ -422 nT
- Last days to a week

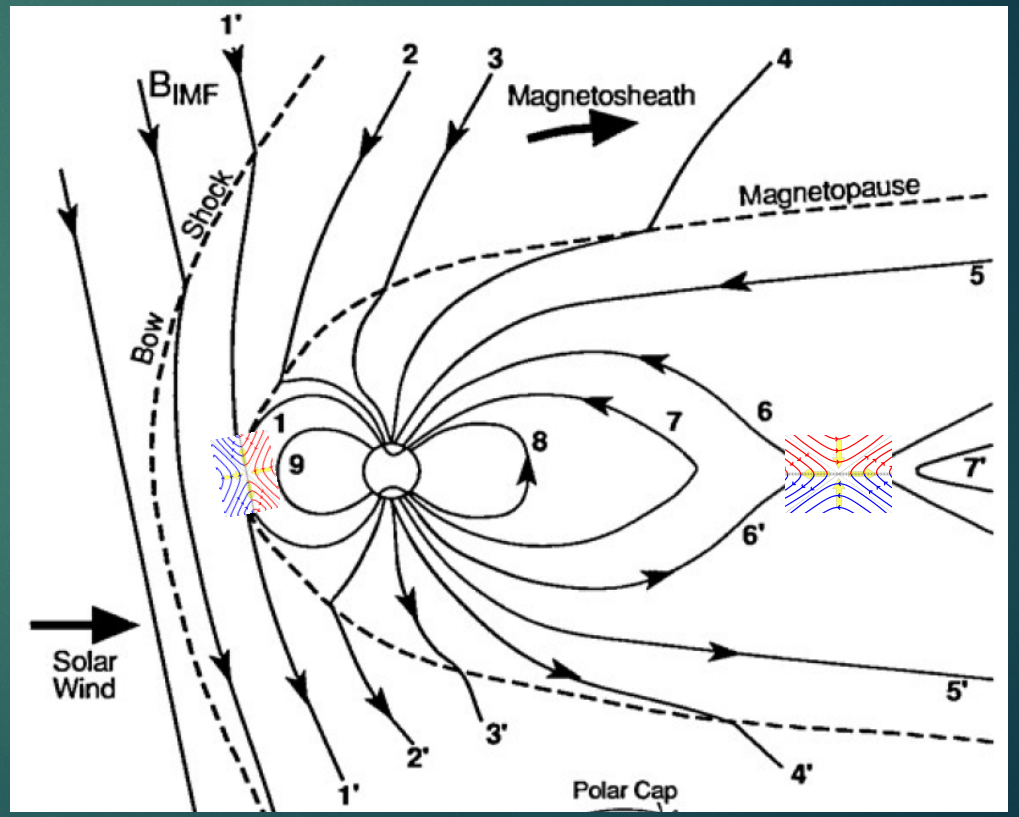




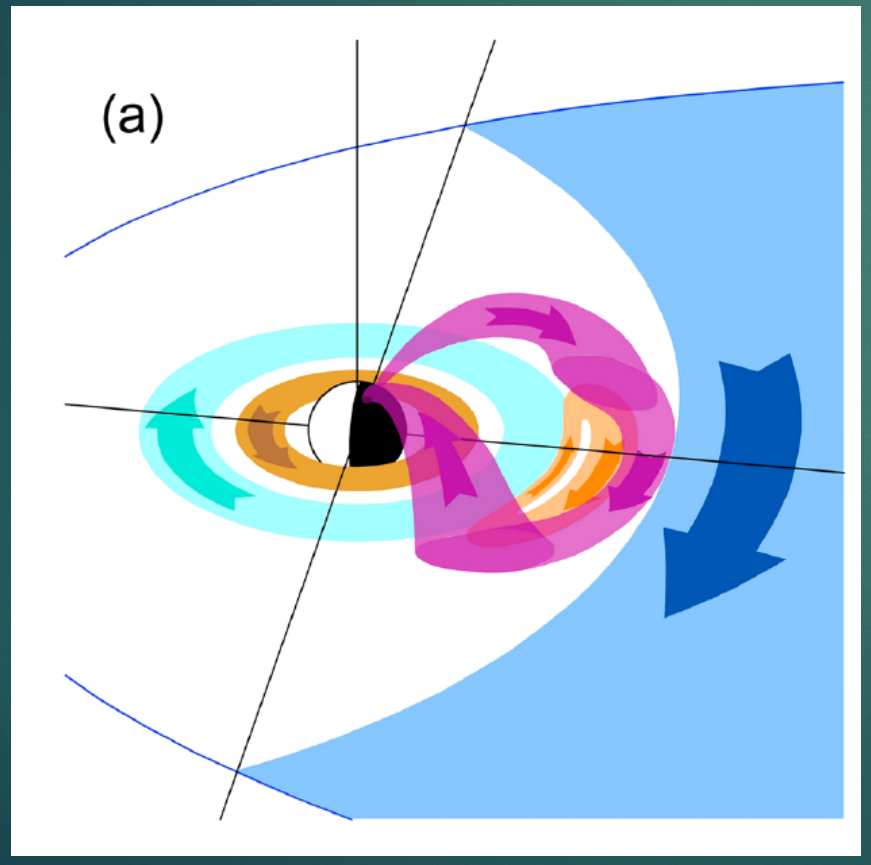
Magnetic Reconnection & Dungey Cycle

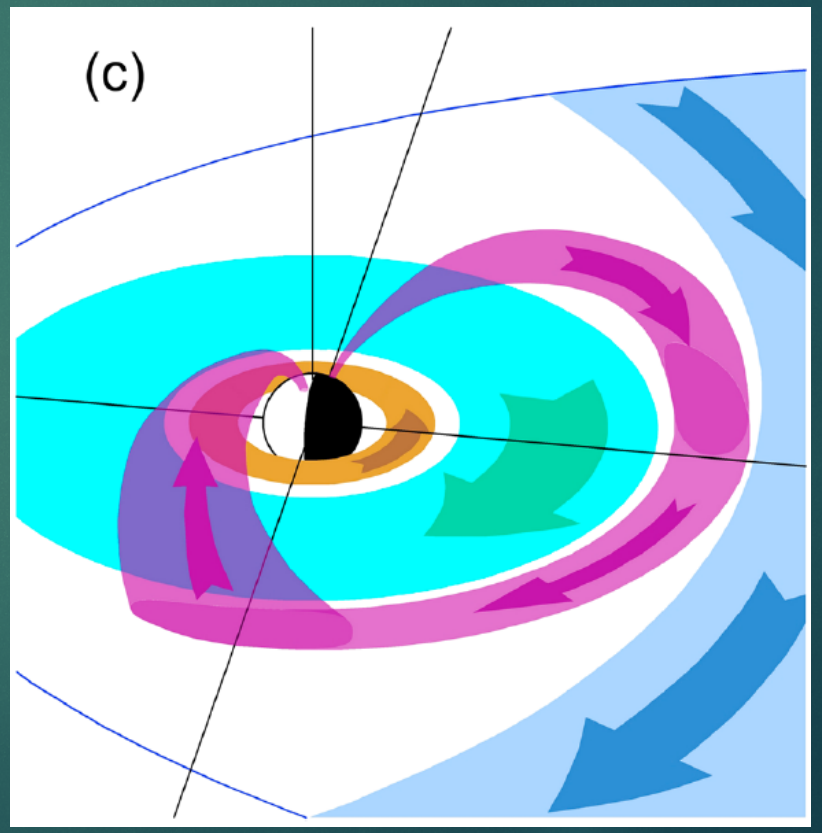
- Cross-Field Particle/Energy Transport



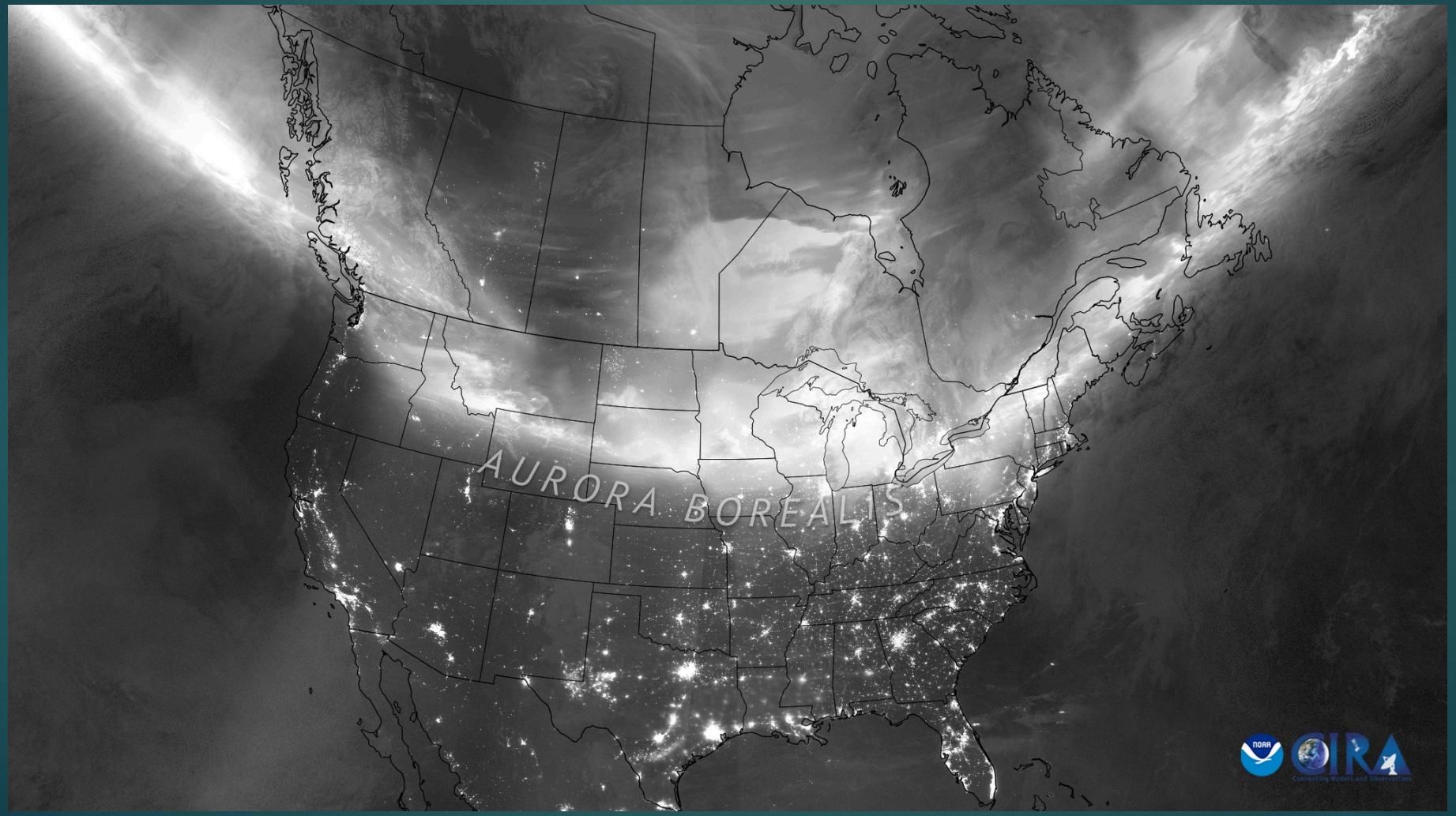


Geomagnetic Storm Currents



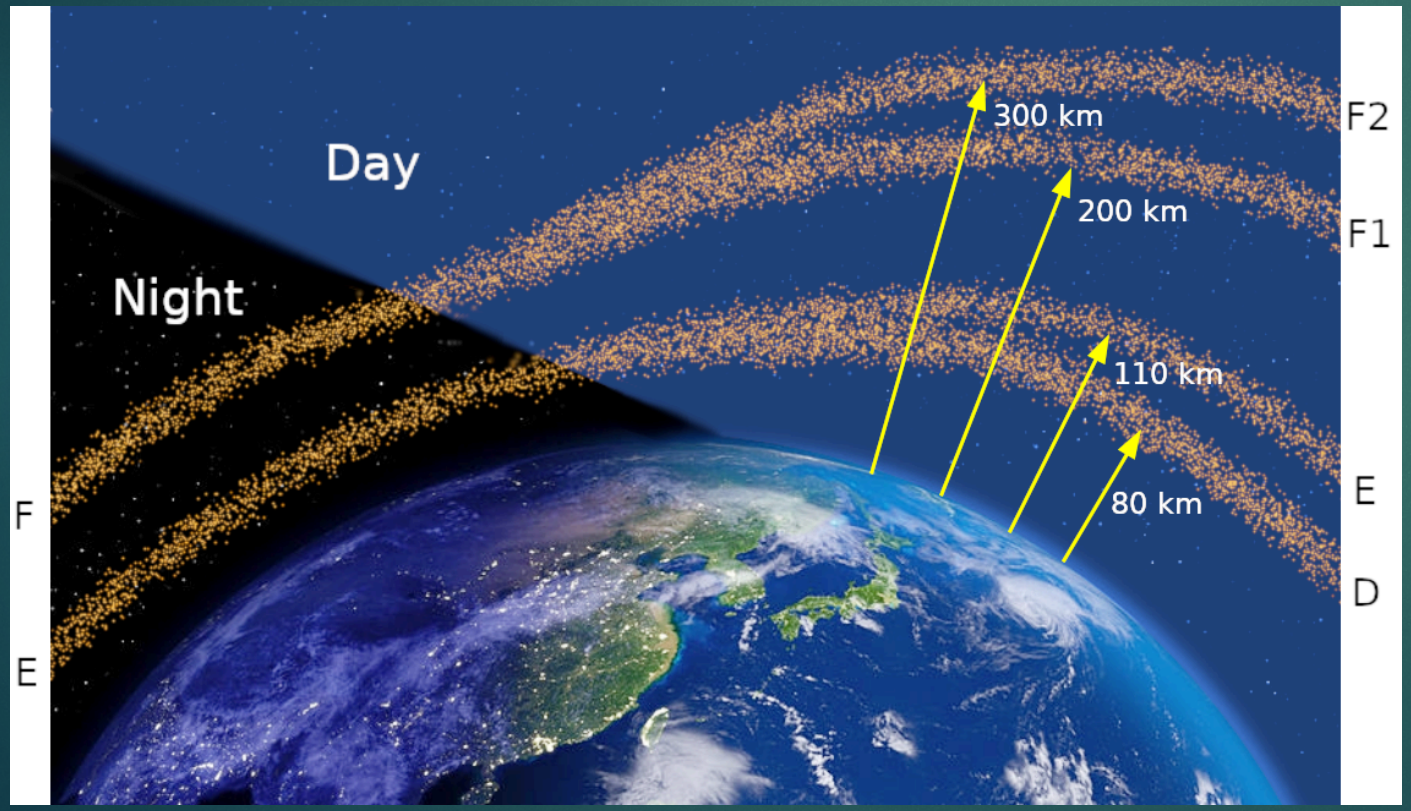


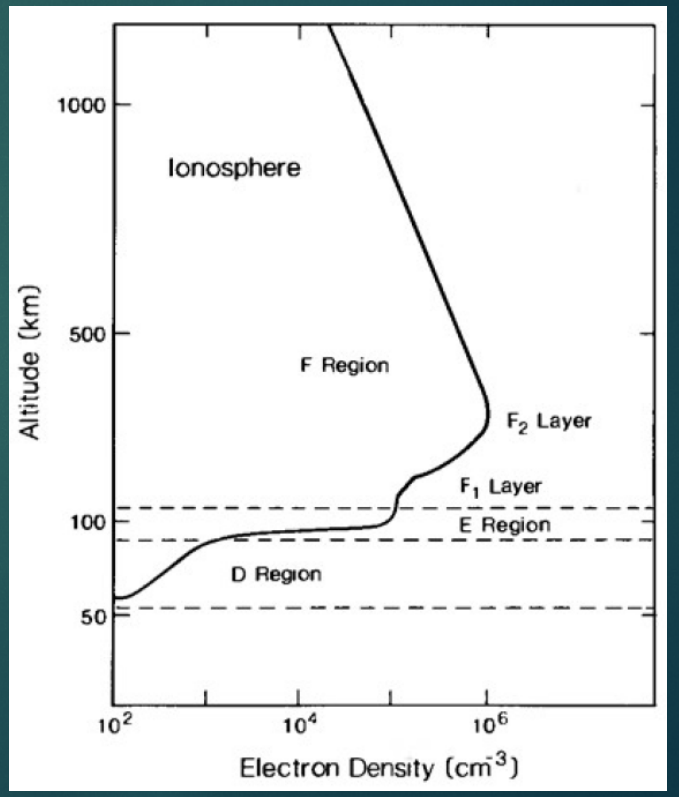
May 10 Auroral Substorm



Earth's Ionosphere

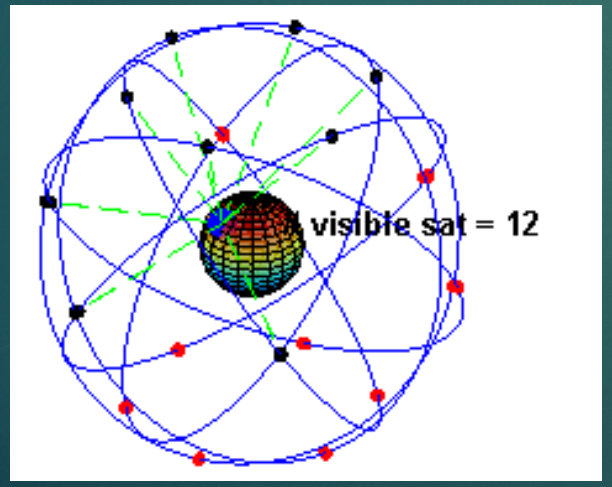
- Ionosphere's Existence (EUV/X-rays)
- Particle Precipitation → Plasma Production, Optical Emissions

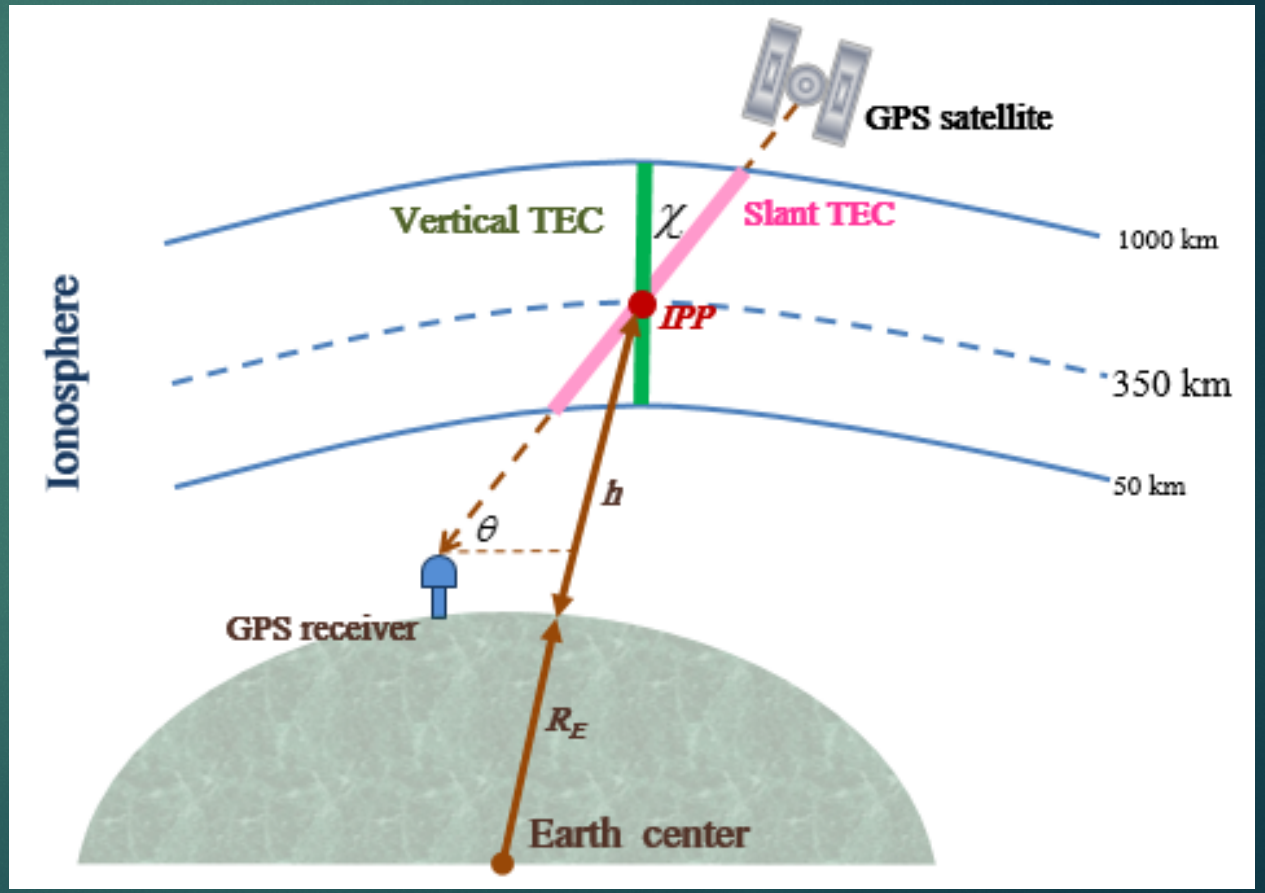




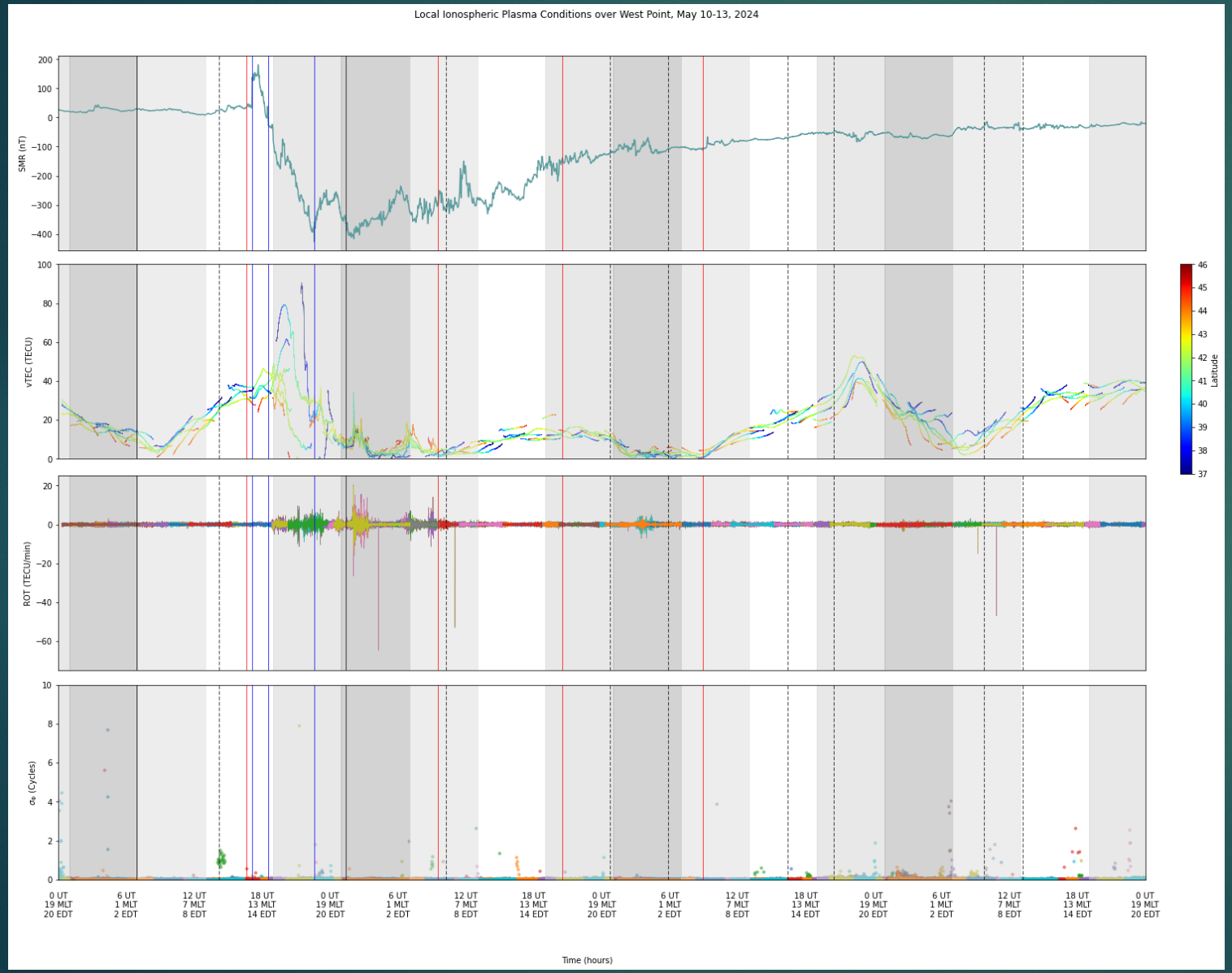
Ionospheric Scintillation

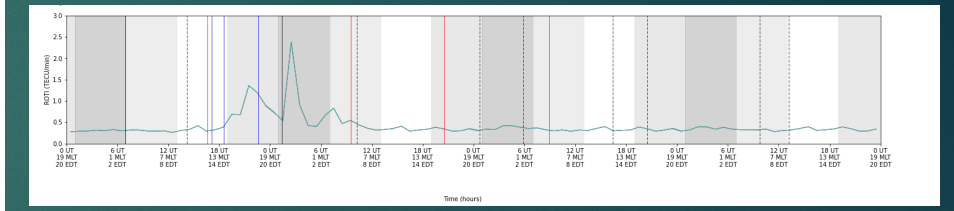
- GPS Satellites (1200-1500 MHz)
- Refraction/Diffraction
- TEC, vTEC, sTEC
- Ionospheric Pierce Point



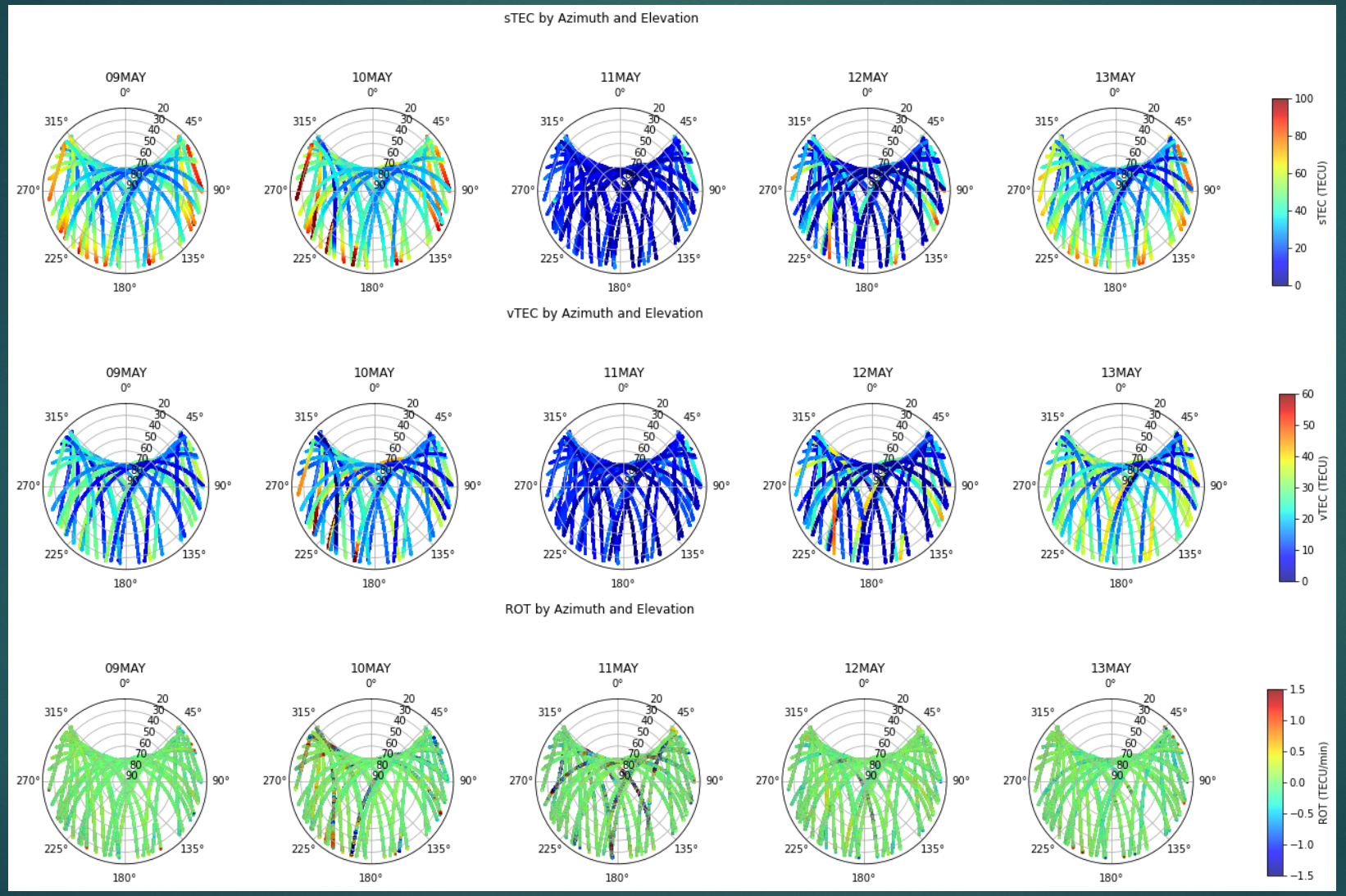


CASES GPS Receiver Data

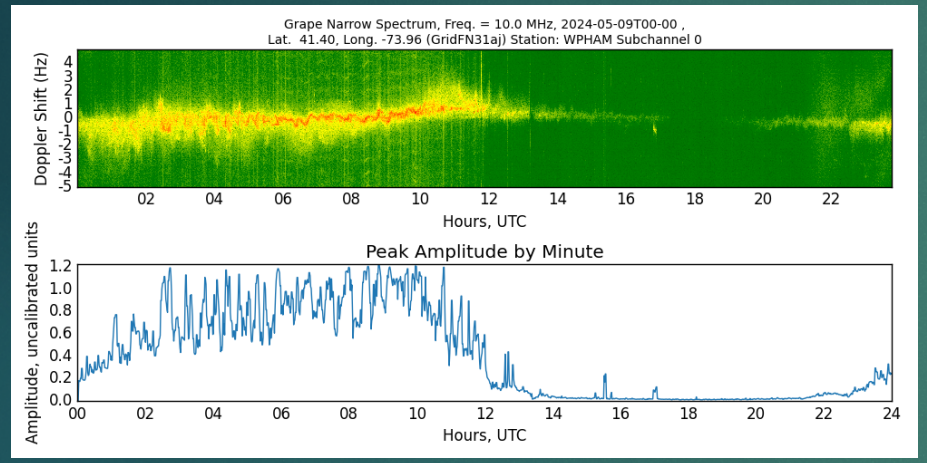


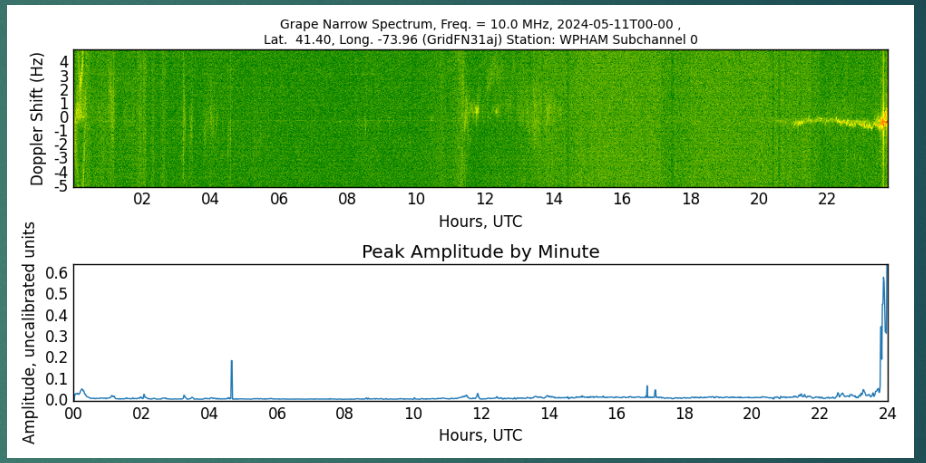


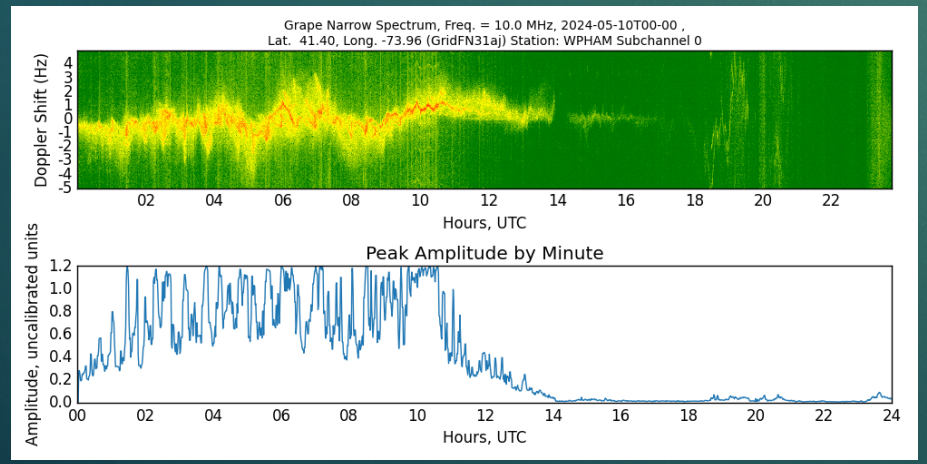
Azimuth/Elevation Scint. Plots

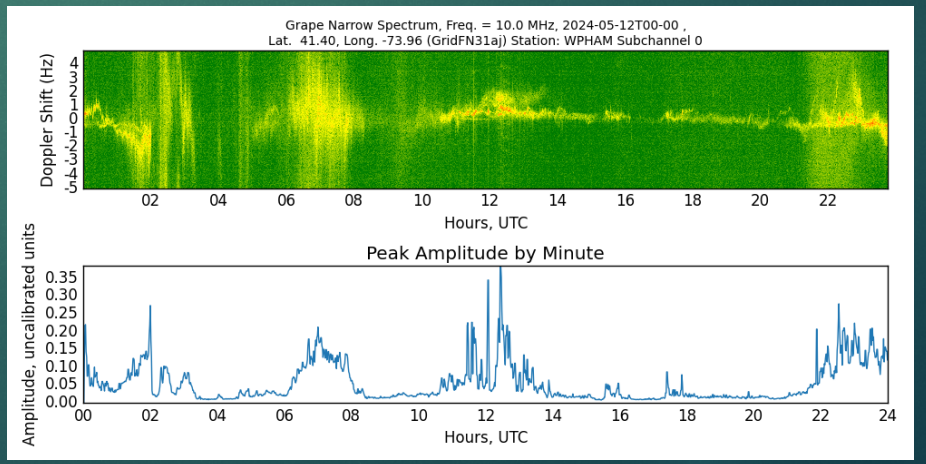


Personal Space Weather Station Doppler (Radio Blackout!)


Grape Narrow Spectrum, Freq. = 10.0 MHz, 2024-05-09T00-00 ,
Lat. 41.40, Long. -73.96 (GridFN31aj) Station: WPHAM Subchannel 0
Doppler Shift (Hz)
Hours, UTC
Peak Amplitude by Minute
Amplitude, uncalibrated units
Hours, UTC


Grape Narrow Spectrum, Freq. = 10.0 MHz, 2024-05-11T00-00 ,
Lat. 41.40, Long. -73.96 (GridFN31aj) Station: WPHAM Subchannel 0
Doppler Shift (Hz)
Hours, UTC
Peak Amplitude by Minute
Amplitude, uncalibrated units
Hours, UTC


Grape Narrow Spectrum, Freq. = 10.0 MHz, 2024-05-10T00-00 ,
Lat. 41.40, Long. -73.96 (GridFN31aj) Station: WPHAM Subchannel 0
Doppler Shift (Hz)
Hours, UTC
Peak Amplitude by Minute
Amplitude, uncalibrated units
Hours, UTC


Grape Narrow Spectrum, Freq. = 10.0 MHz, 2024-05-12T00-00 ,
Lat. 41.40, Long. -73.96 (GridFN31aj) Station: WPHAM Subchannel 0
Doppler Shift (Hz)
Hours, UTC
Peak Amplitude by Minute
Amplitude, uncalibrated units
Hours, UTC

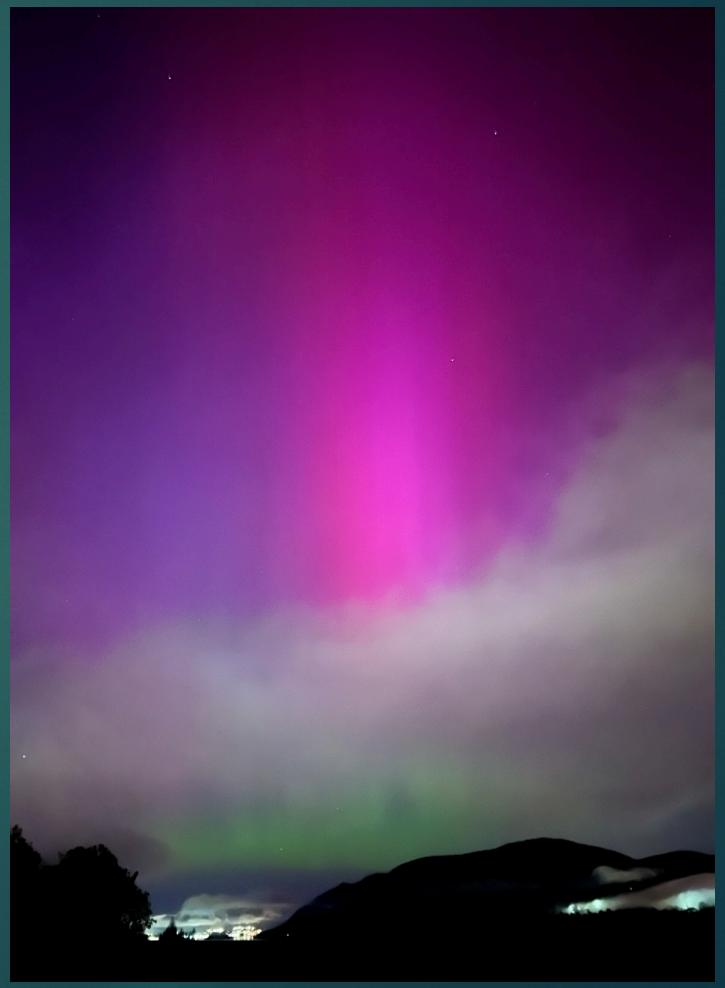
Now, the RX888

From 2.5 – 25 MHz

Working On…

- RX888 to come
- More global context
- PRN Breakdown
- PSD Analysis, Flares
- GPS Deviation
- Geolocation

Cite: SuperMag, Shue+ (1997), Boyle+ (1997)

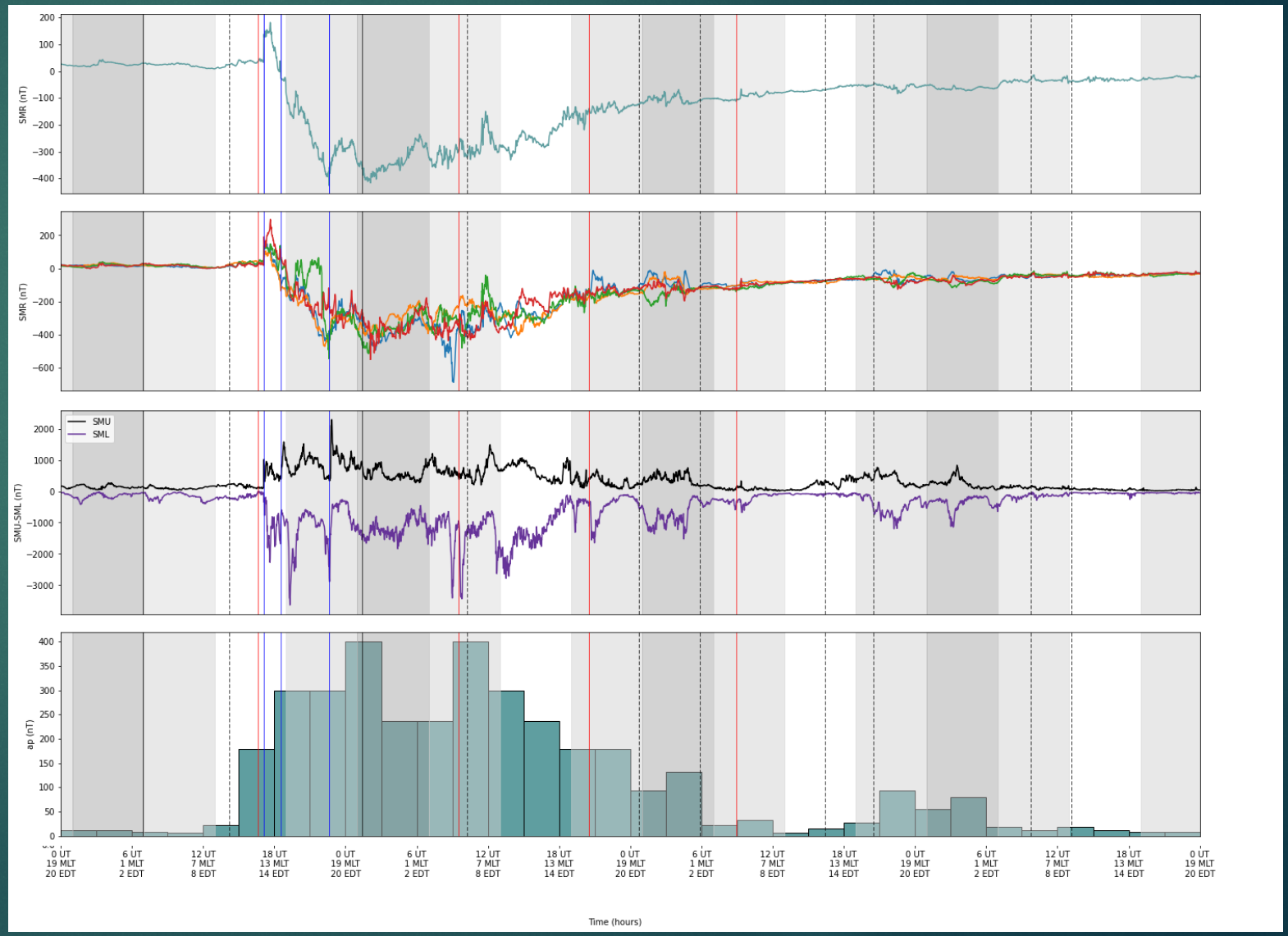


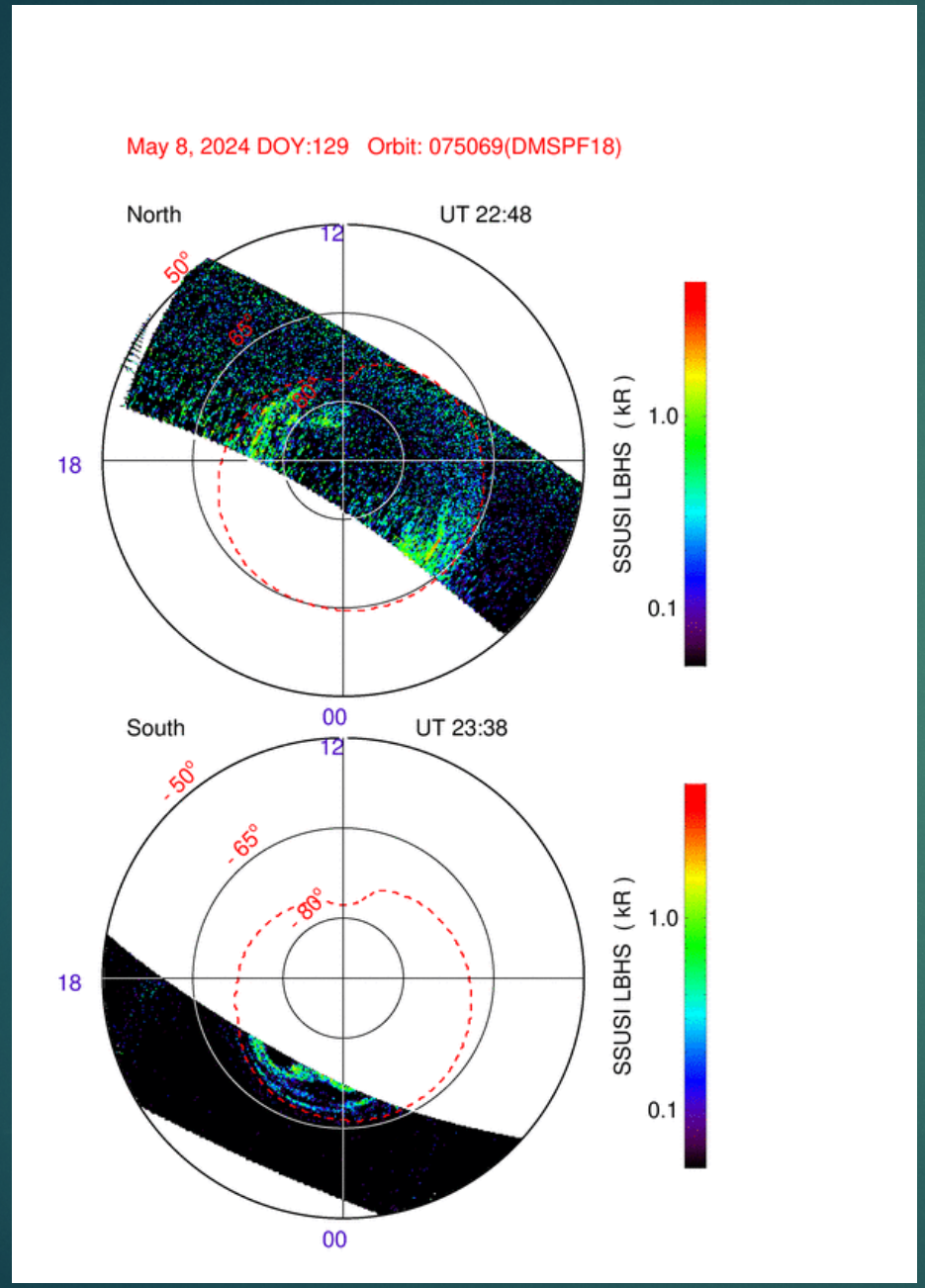
SUPPLEMENTAL!

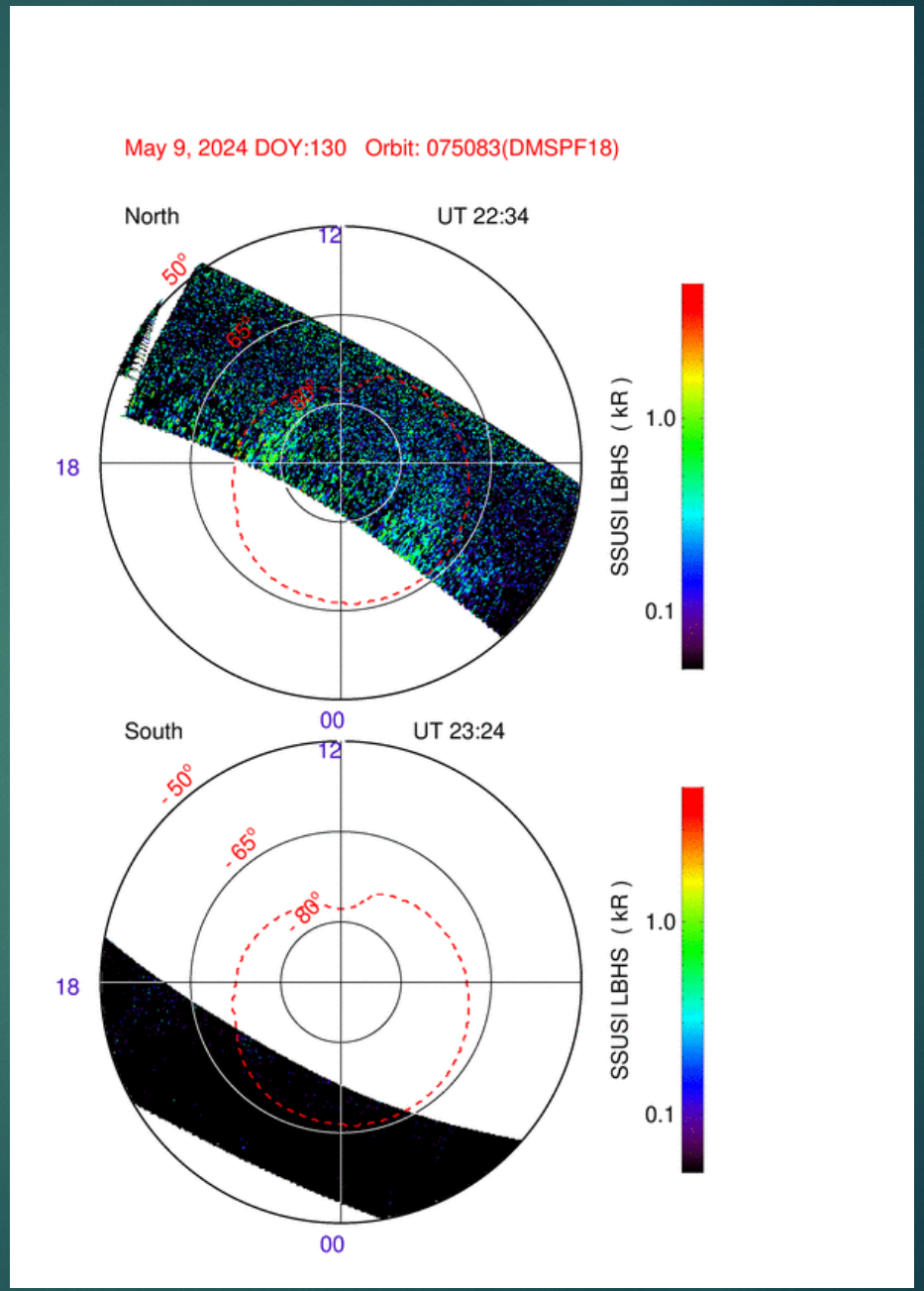
…

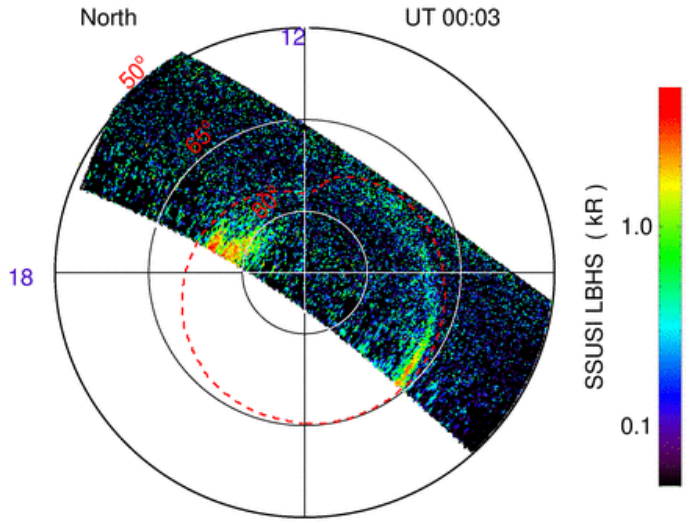
May 10 Geomagnetic Indices

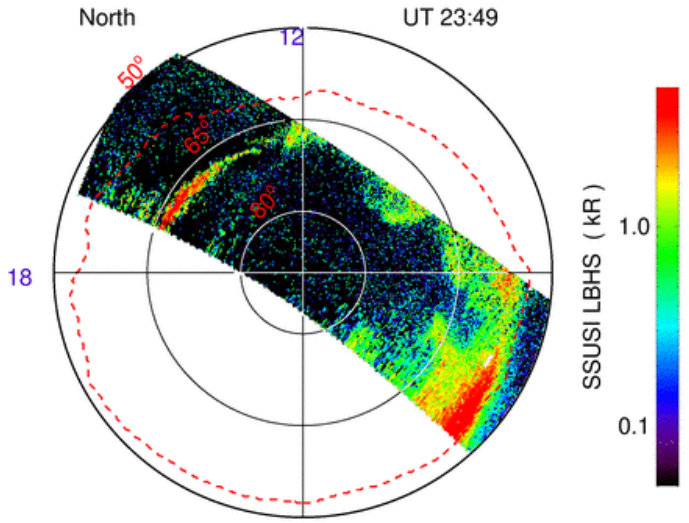
- SMR
  - Better Dst
  - MP Compression
  - Ring Current
  - Storm
- SME = SMU-SML
  - Better AE
  - Electrojet
  - Substorm
- Ap
  - Tail Convection
- CPCP
  - Next Slide




May 8, 2024 DOY:129 Orbit: 075069(DMSPF18)
North
UT 22:48
12
18
00
50°
65°
80°
SSUSI LBHS (kR)
1.0
0.1
South
UT 23:38
-50°
-65°
-80°

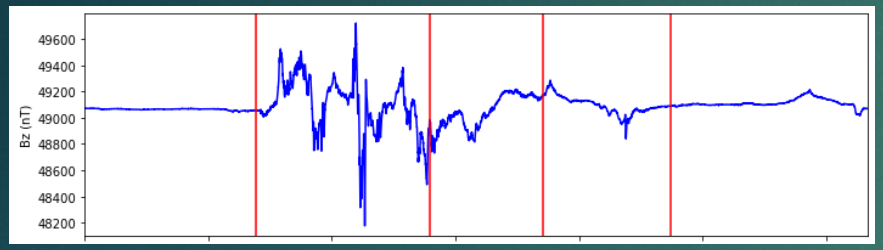

May 9, 2024 DOY:130 Orbit: 075083(DMSPF18)
North
UT 22:34
12
18
00
50°
65°
80°
SSUSI LBHS (kR)
1.0
0.1
South
UT 23:24
-50°
-65°
-80°

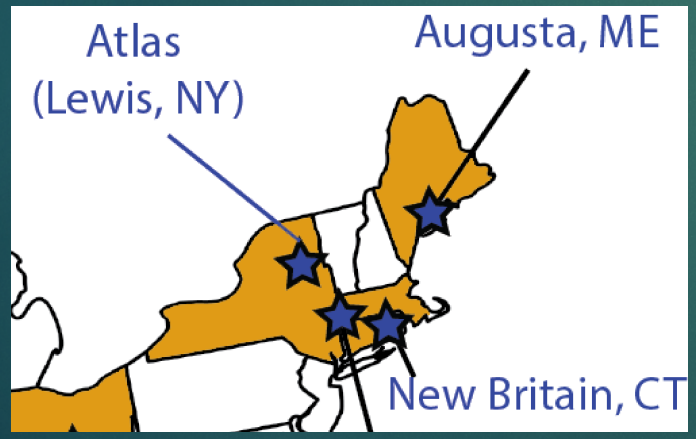

May 10, 2024 DOY:131 Orbit: 075096(DMSPF18)
North
UT 00:03
12
18
00
50°
65°
80°
SSUSI LBHS (kR)
1.0
0.1
South
UT 00:54
-50°
-65°
-80°

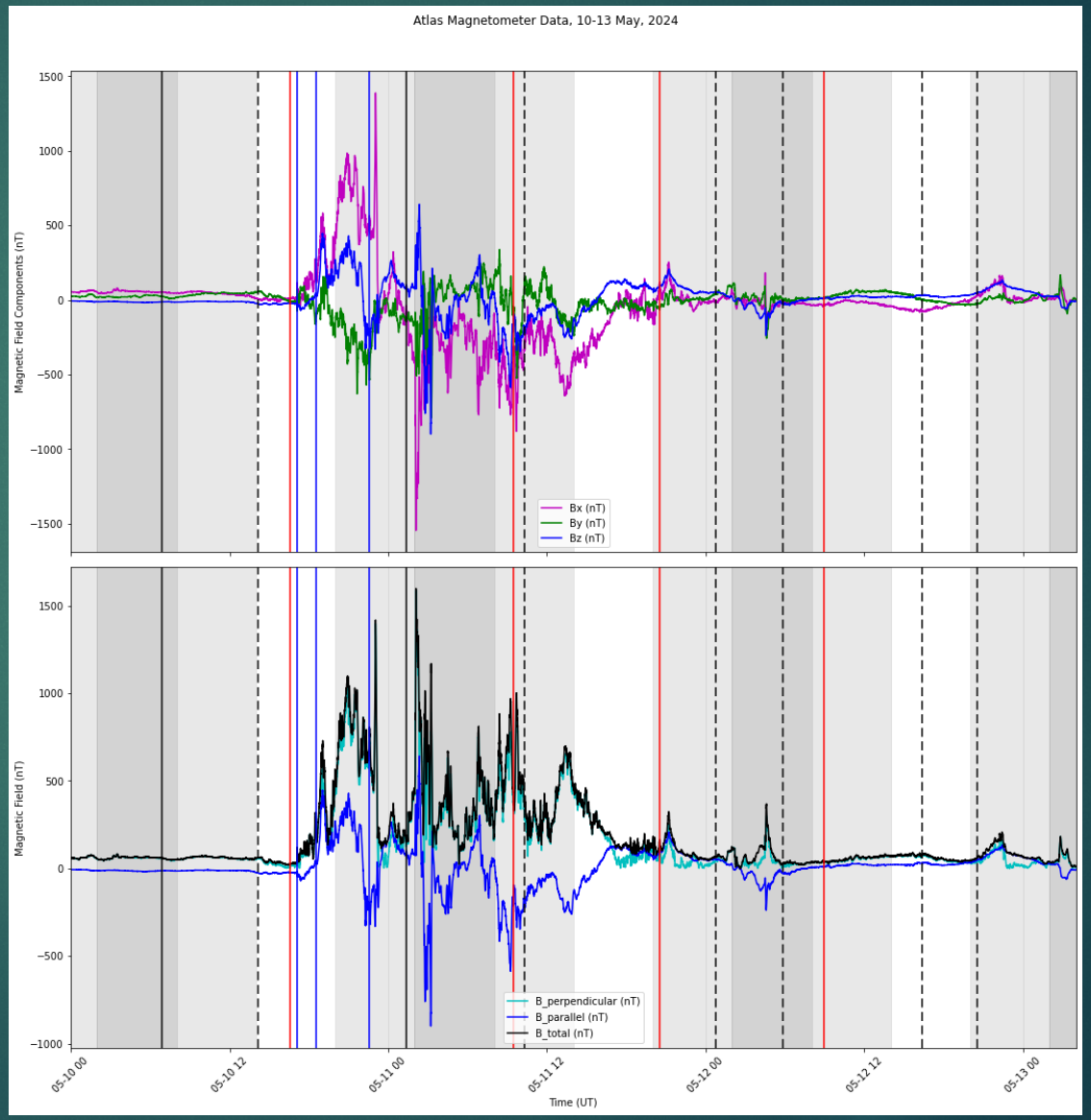

May 11, 2024 DOY:132 Orbit: 075110(DMSPF18)
North
UT 23:49
12
18
00
50°
65°
80°
SSUSI LBHS (kR)
1.0
0.1
South
UT 00:41
-50°
-65°
-80°

CPI Magnetometer Perturbations

- Magnetic Field Line Oscillations

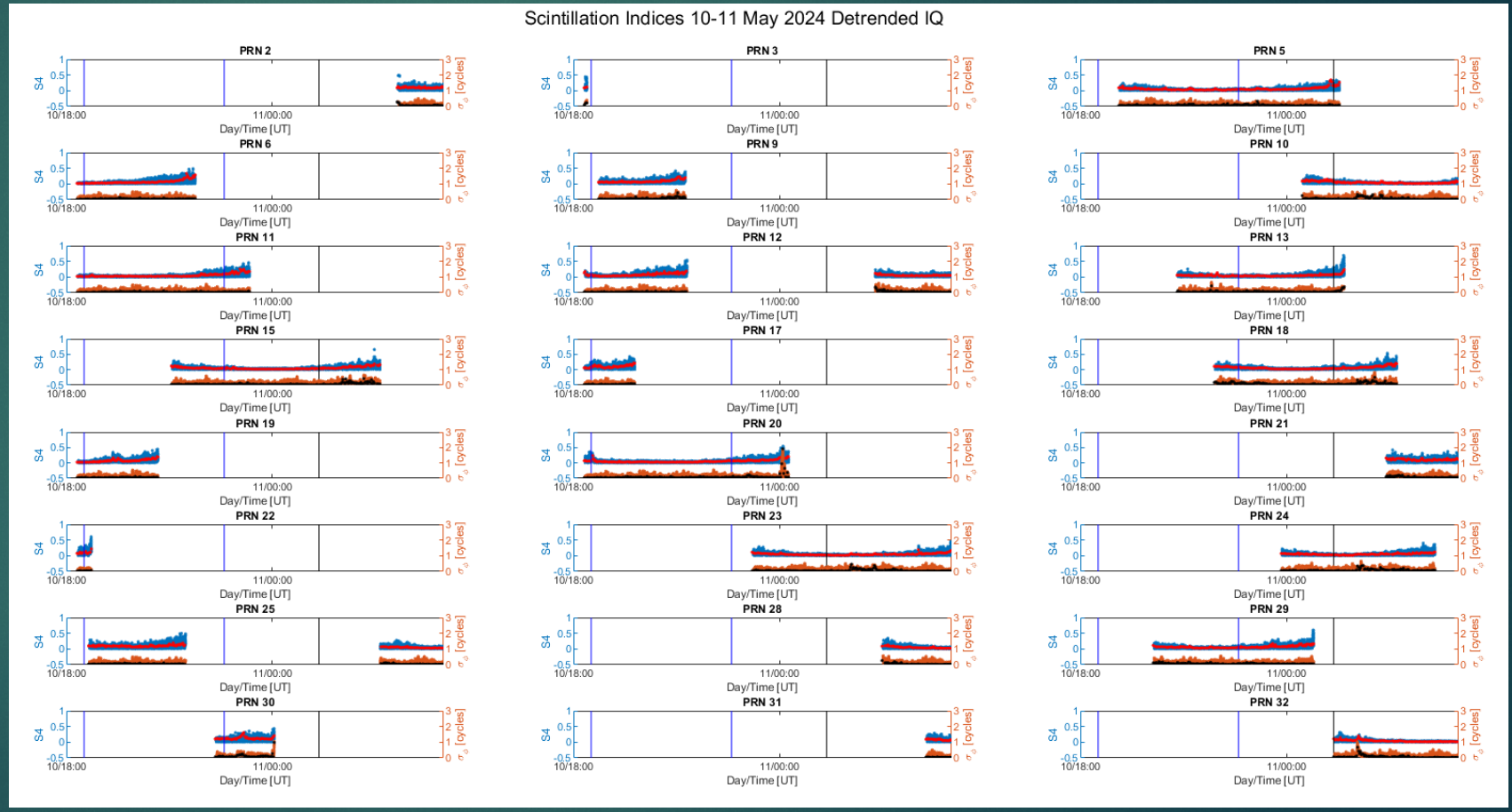






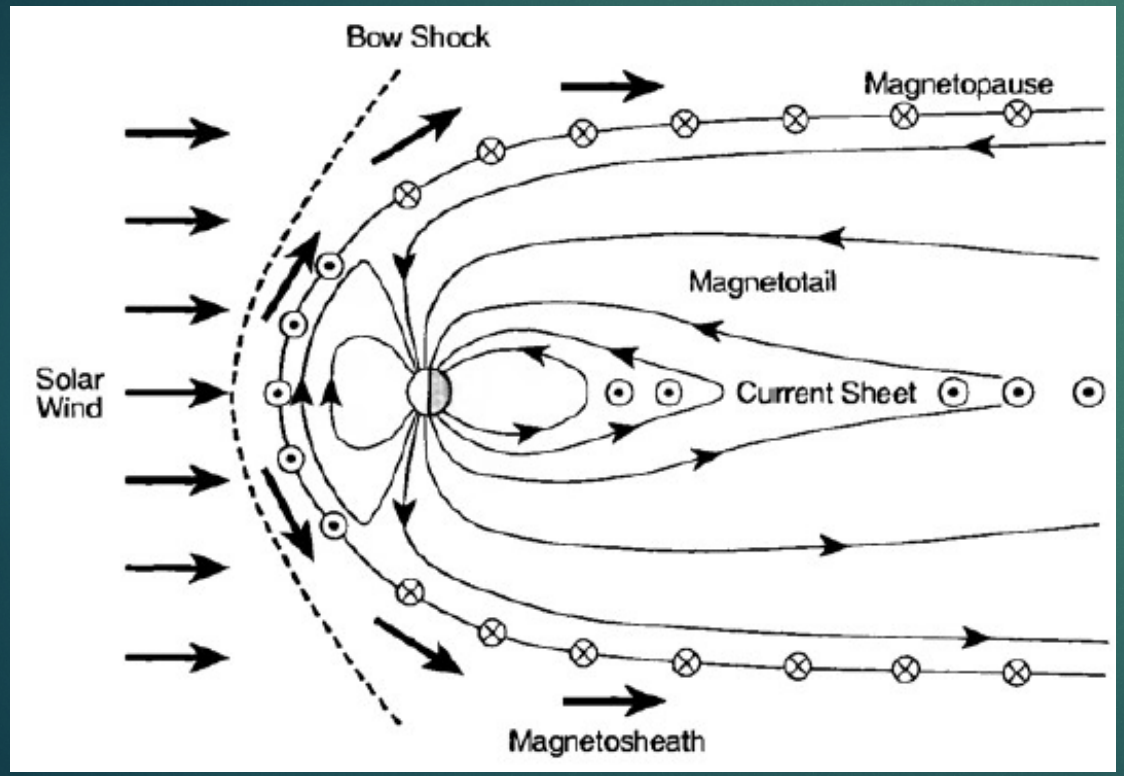
Scint. by PRN

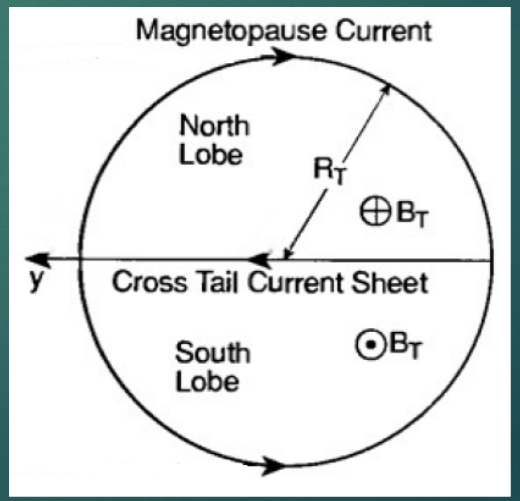
- PSD Calculations
  - Phase vs. Amp.
  - Ref. vs. Diff.

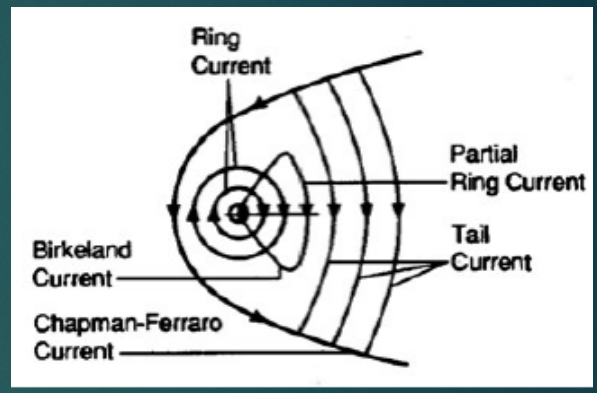


Earth's Magnetosphere

- Magnetopause Current, Ring Current, Field-Aligned Currents

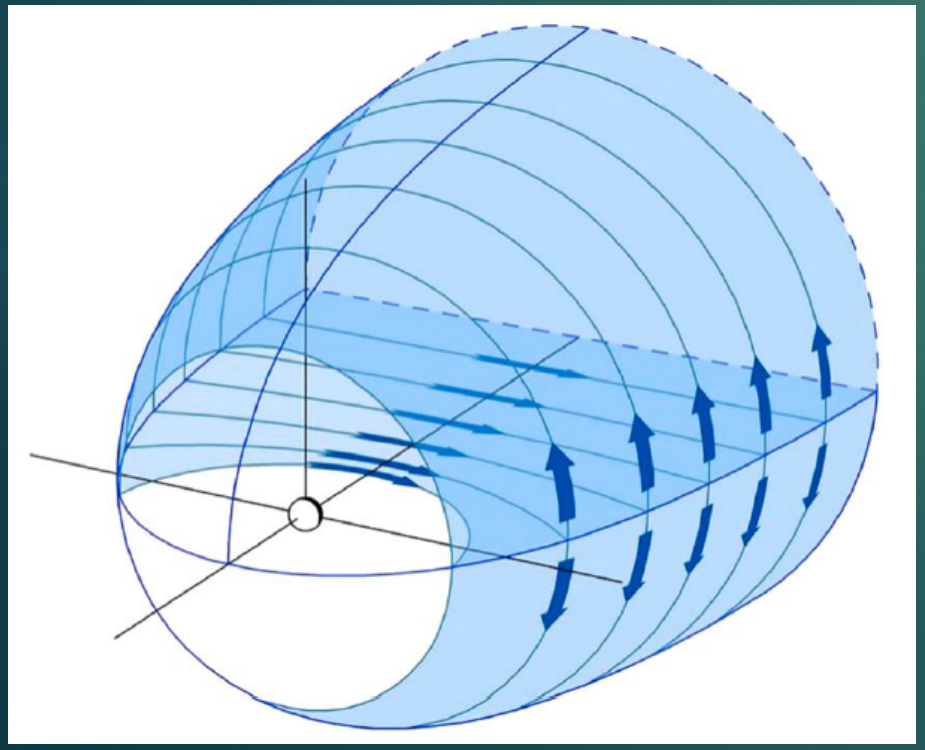


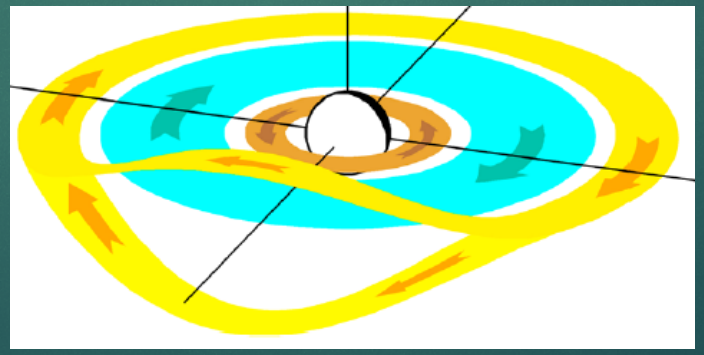


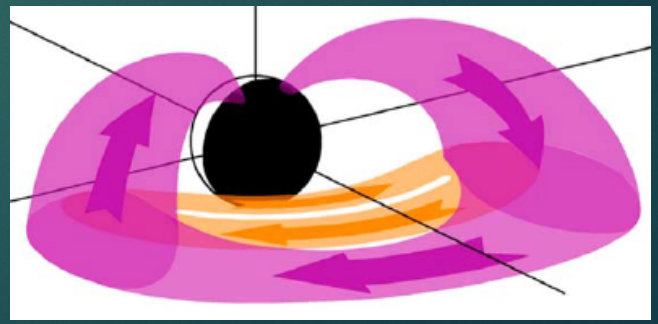


Magnetospheric Current Systems

- Magnetopause Current
- Ring Current, Birkeland Currents, Auroral Electrojet

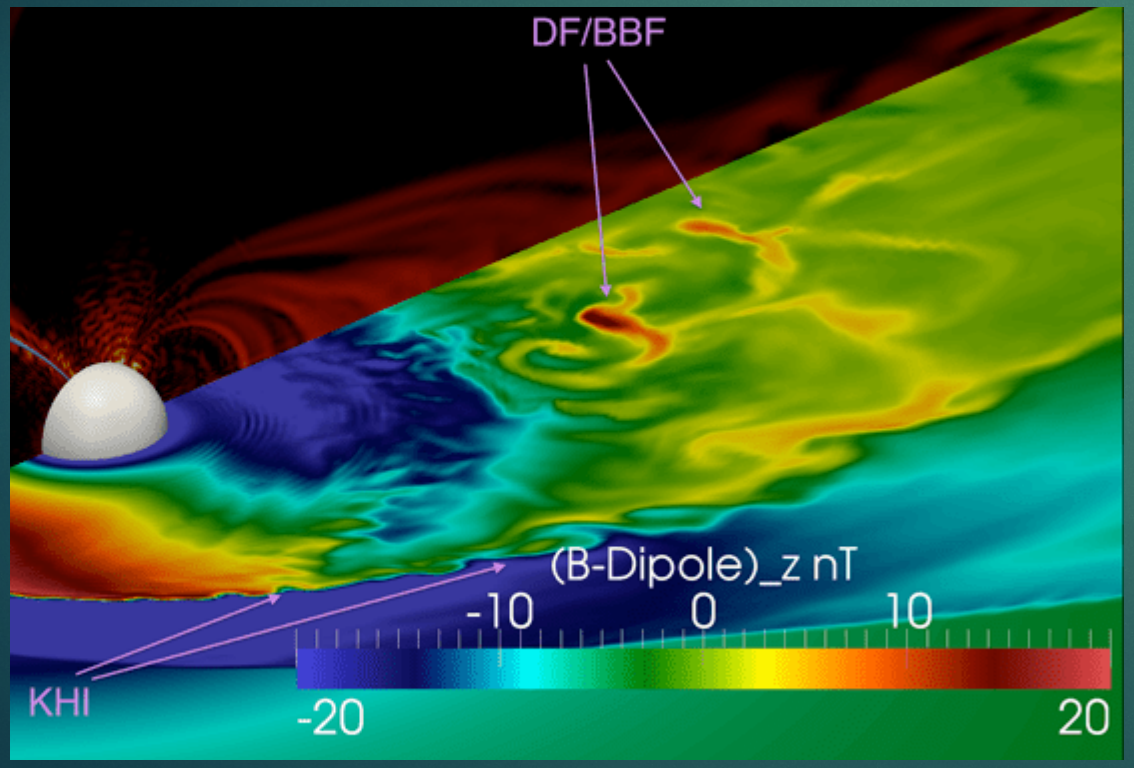


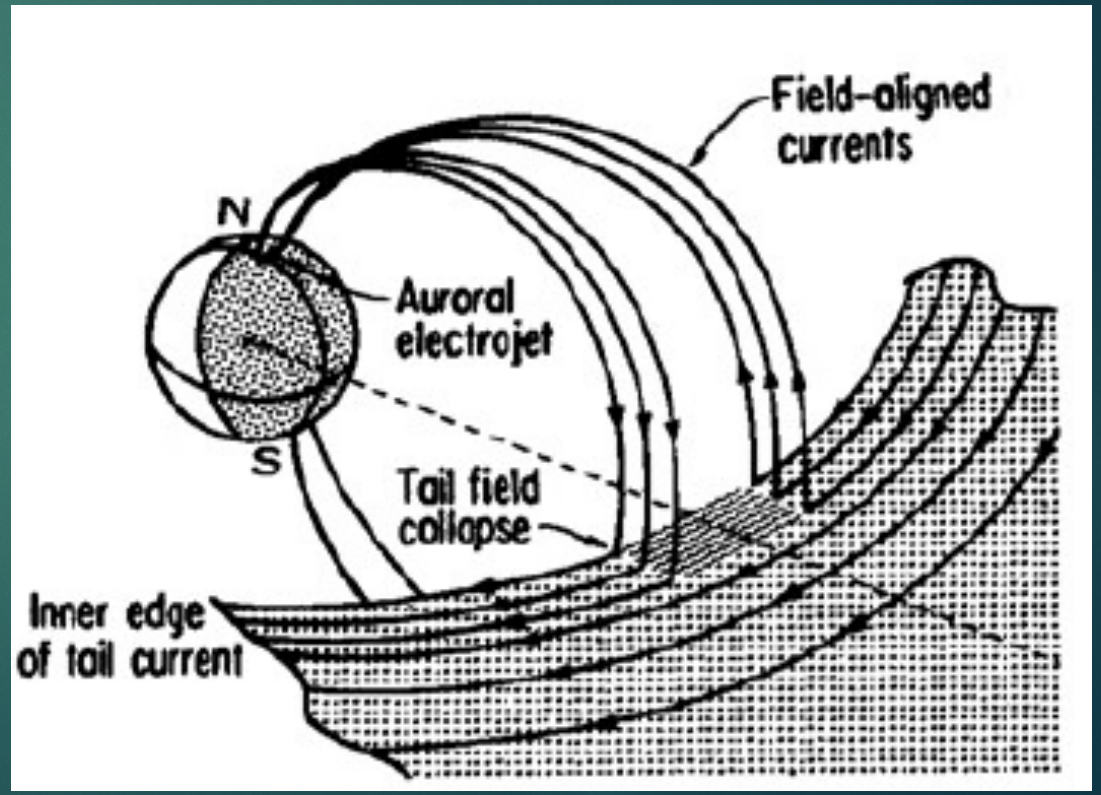




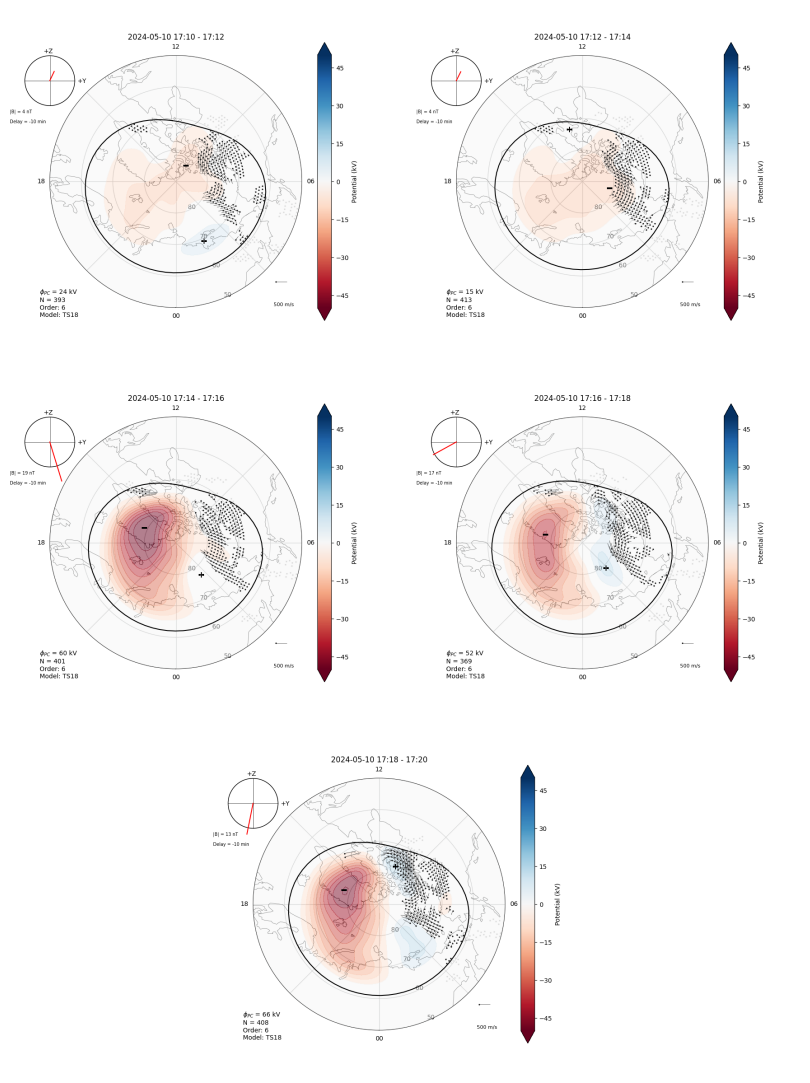
Auroral Substorms

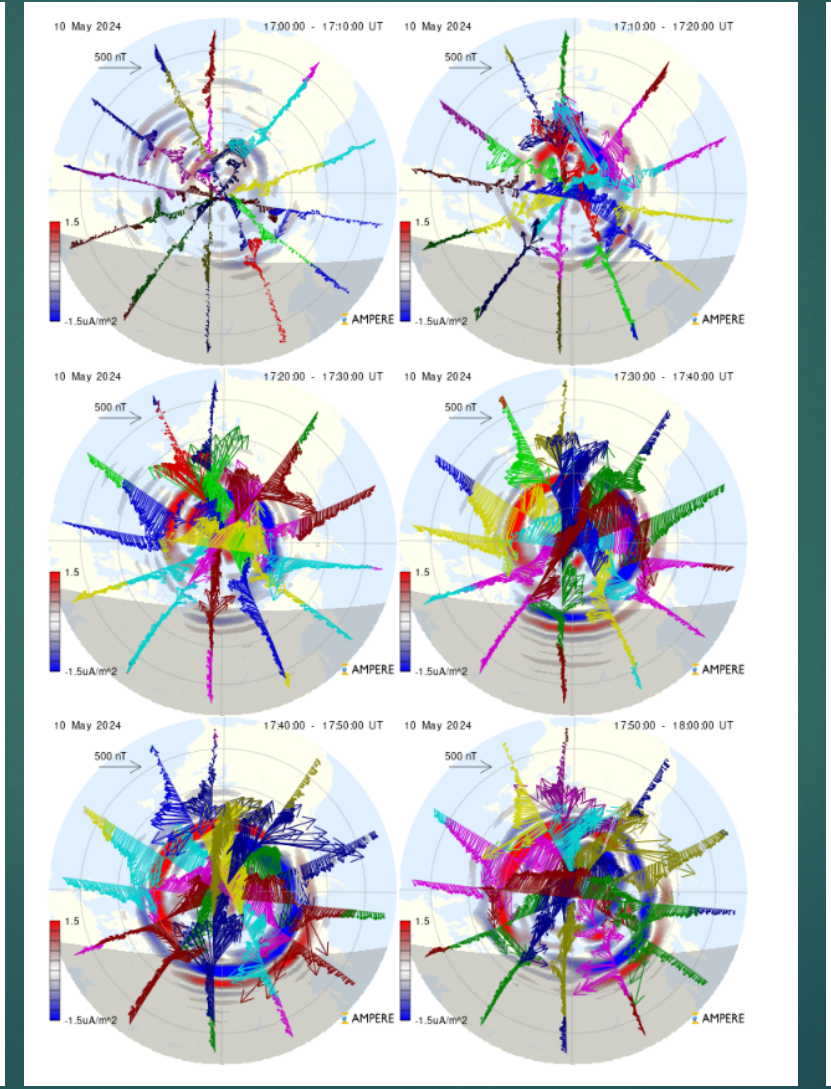
- 2x Reconnection, Bubble, FACs, Electrojet
- Several times daily, last a few hours

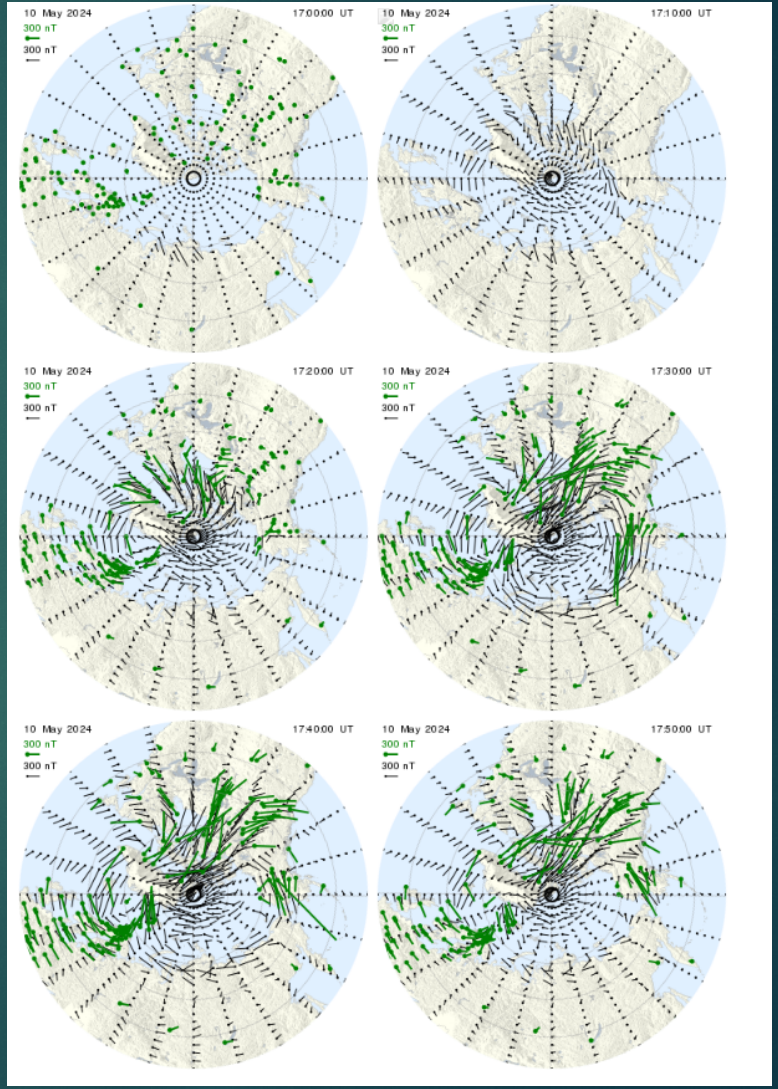




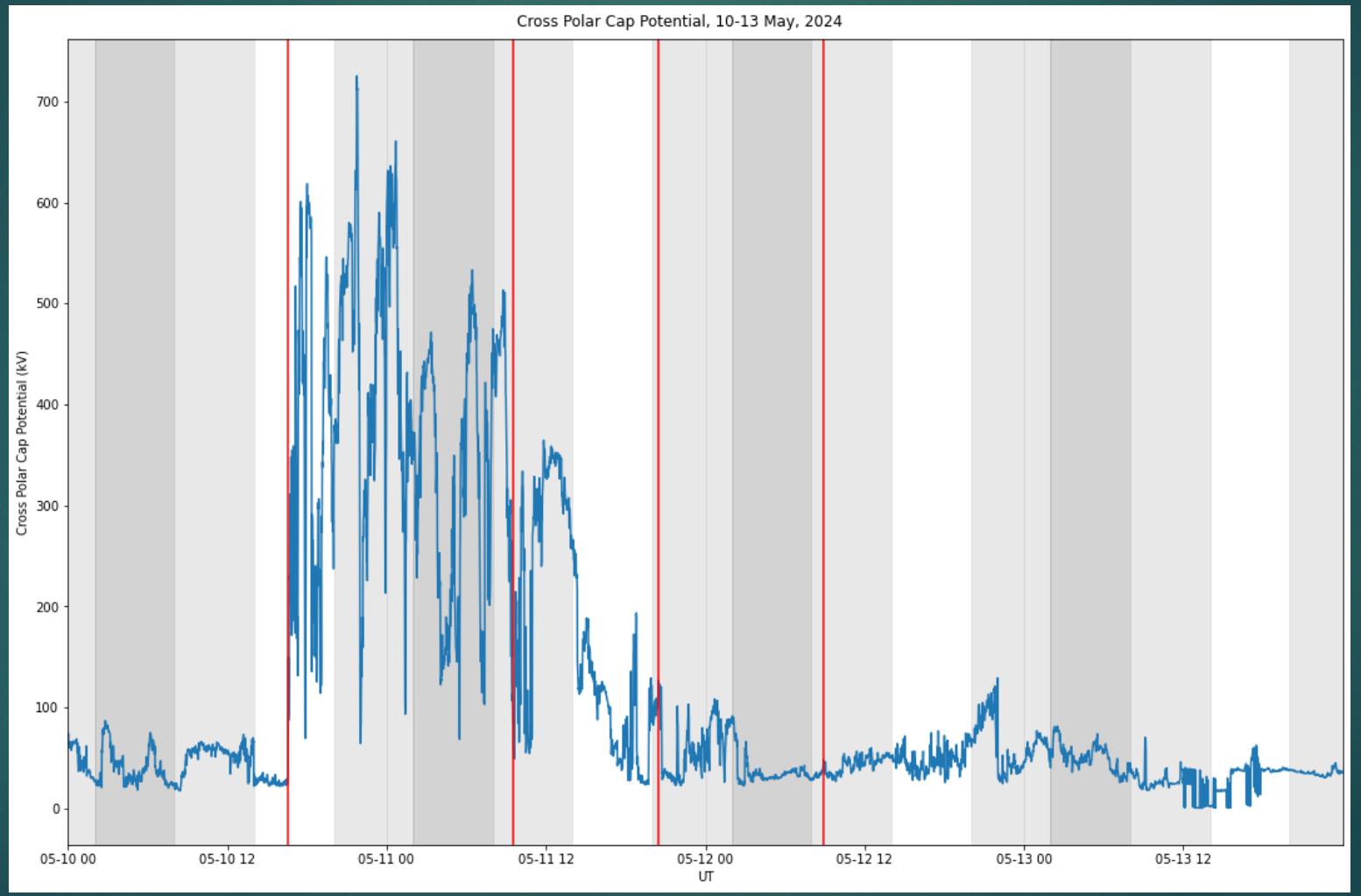
Global Context 1 – SSC







CPCP > 700 kV!


Cross Polar Cap Potential, 10-13 May, 2024
Cross Polar Cap Potential (kV)
700
600
500
400
300
200
100
0
05-10 00
05-10 12
05-11 00
05-11 12
05-12 00
05-12 12
05-13 00
05-13 12
UT